DEPARTMENT OF THE AIR FORCE
AIR FORCE CIVIL ENGINEER CENTER
JOINT BASE CHARLESTON SOUTH CAROLINA

08 November 2016

Ms. Dana T. Holsclaw
AFCEC/CZO, JB Charleston IST
203 S. Davis Drive, Bldg 247, 1st Floor
Joint Base Charleston, SC 29404-4707

Mr. Joel P. Padgett, P.G., Geologist/ Hydrologist
Underground Storage Tank Program
Bureau of Land and Waste Management
South Carolina Dept. of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

RE: Draft Final Corrective Action Plan, AOC I (ST013), Base Gasoline Station Leak (GWPD #13446), Joint Base Charleston-Air, South Carolina

Dear Mr. Padgett,

The purpose of this letter is to submit two (2) hardcopies and electronic copies (CDs) of the subject plan for Area of Concern I (AOC I, ST013, GWPD #13446) site at Joint Base Charleston-Air, South Carolina for your review and approval. Should you have any questions or comments regarding the attached, please contact me by telephone at (843) 963-2701 or by email at dana.holsclaw@us.af.mil.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. This document is signed and certified in accordance with R.61-79.270.11 and 270.30(K).

Sincerely,

Dana T. Holsclaw

DANA T. HOLSCLAW
Remedial Project Manager

cc: Niels D. L. van Hoesel, PE (FPM)
Scott Saroff, CPG, PG (FPM)

DRAFT FINAL

CORRECTIVE ACTION PLAN

FOR

SOURCE SOIL REMOVAL AND GROUNDWATER TREATMENT

AOC I (ST013) - BASE GASOLINE STATION LEAK
UNDERGROUND STORAGE TANK
UST PERMIT # 13446
GWPD Site No. A-10-AA-13446

JOINT BASE CHARLESTON-AIR
NORTH CHARLESTON, SC
FACILITY ID SC3570024460

Performance Based Remediation
Contract Number: FA8903-13-C-0006

Prepared for

AIR FORCE CIVIL ENGINEER CENTER
2261 Hughes Ave., Suite 163
Lackland AFB, Texas 78236-9853

November 2016

Prepared by:

FPM Remediations, Inc.
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Corrective Action Plan
for
Source Soil Removal and Groundwater Treatment

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Site:

AOC 1 (ST013), UST Permit #13446
Joint Base Charleston – Air (JBCA)
Charleston, South Carolina

Submitted to:

South Carolina Department of Health and Environmental Control (SCDHEC)
2600 Bull Street
Columbia, South Carolina 29201

Prepared for:

Joint Base Charleston – Air
Charleston, South Carolina

Prepared by:

FPM Remediations, Inc.
181 Kenwood Avenue
Oneida, NY 13421

November 2016

Author: _____
Niels van Hoesel, PE
Title: Site Lead
Date: 11/2/2016

Reviewer: _____
Scott Saroff, CPG #7745
Title: Project Manager
Date: 11/3/2016

Engineer-in-Charge: _____
Gaby Atik, PE # 31468
Title: Program Manager
UST Rehabilitation Contractor #446
Date: 11/3/2016

Reviewer: HOLSCLAW.DANA.T.1381191083
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DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USAF, cn=HOLSCLAW.DANA.T.1381191083
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Dana Holsclaw
Title: JBCA Remedial Project Manager
Date: _____

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
Accutest	SGS Accutest Laboratories, Inc.
ACQAP	Annual Contractor QAPP
AFCEC	Air Force Civil Engineer Center
AOC	Area of Concern
AS/SVE	Air Sparge/Soil Vapor Extraction
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, and Total Xylenes
CAP	Corrective Action Plan
CCR	Construction Completion Report
CMI	Corrective Measures Implementation
CO	Contracting Officer
COC	Chemical of Concern
COR	Contracting Officer Representative
DOT	Department of Transportation
DQO	Data Quality Objective
Earth Tech	Earth Tech, Inc.
ERPIMS	Environmental Resources Program Information Management System
FSP	Field Sampling Plan
FPM	FPM Remediations, Inc.
GWPD	Groundwater Protection Division
HSP	Health and Safety Plan
JBCA	Joint Base Charleston-Air
LSA	Limited Site Investigation
LTM	Long Term Management
MTBE	Methyl tertiary butyl ether
NAVD	North American Vertical Datum
NFA	No Further Action
No.	Number
OBC+®	Oxygen Biochem Plus

PBR	Performance Based Remediation
PID	Photoionization Detector
ppm	parts per million (by mass)
ppm/v	parts per million by volume (air)
PVC	polyvinyl chloride
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RBSL	Risk Based Screening Level
RCRA	Resource Conversation and Recovery Act
RDW	Remediation-Derived Waste
RPM	Remedial Project Manager
SC	Site Closeout
SCDHEC	South Carolina Department of Health and Environmental Control
SOW	Scope of Work
UFP-QAPP	Uniform Federal Policy Quality Assurance Project Plan
UIC	Underground Injection Control
URS	URS Group, Inc.
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
WM	Waste Management

1 INTRODUCTION

This document presents the Corrective Action Plan (CAP) for corrective action activities at Area of Concern (AOC) I (ST013) Base Gasoline Station Leak, Underground Storage Tank (UST) Permit #13446 (GWPD Site No. A-10-AA-13446) at Joint Base Charleston-Air (JBCA), South Carolina. The location of JBCA and AOC I are illustrated on **Figure 1**.

1.1 Authority

FPM Remediations, Inc. (FPM), in association with URS Group, Inc. (URS), has been contracted by the Air Force Civil Engineer Center (AFCEC) under AFCEC Contract FA8903-13-C-0006 to conduct performance based remediation (PBR) at certain sites at JBCA. AOC I (ST013) Base Gasoline Station Leak is one of those sites. Proposed remedial activities at AOC I include excavation of contaminated unsaturated and saturated soils and treatment of groundwater, and post remediation groundwater monitoring. The goal of these remedial activities is to achieve a determination of No Further Action (NFA) by South Carolina Department of Health and Environmental Control (SCDHEC), and Site Closeout (SC) after the remedial system (i.e., proposed infiltration galleries) has been decommissioned and monitoring wells abandoned.

1.2 Purpose and Scope

The objective of this CAP is to complete an excavation of contaminated soils, treatment of groundwater through placement of treatment chemicals within the excavation prior to backfill, and injection of treatment chemicals in the area of contamination. This will be followed by performance monitoring and then quarterly LTM groundwater monitoring events to demonstrate achievement of the SCDHEC risk-based screening levels (RBSLs) (Appendix D, SCDHEC, 2016) for two consecutive quarters, and upon achieving this requirement, petitioning SCDHEC for NFA. RBSLs are risk based action levels for a chemical of concern (COC) based on a $1x10^{-6}$ target risk. A historical site features map is provided as **Figure 2**. The soil contamination areas are shown on **Figure 3** and the extent of groundwater contamination is shown on **Figure 4**.

This CAP presents the objectives, tasks, and the field activities necessary to achieve SC. This CAP is completed in accordance with the SCDHEC UST Program Programmatic Quality Assurance Project Plan (QAPP) (SCDHEC, 2015) as modified by the Annual Contractor QAPP (ACQAP) (FPM, 2015a). This CAP also includes the revised ACQAP Worksheets for the soil samples expected to be collected during Corrective Measures Implementation (CMI) activities and the groundwater samples expected to be collected during monitoring after the CMI activities are completed.

1.3 Site Background

The AOC I (ST013) site is a former automotive service station, once occupied by former Building 210. During station operation, fuel was stored in eight USTs. In 1983, a 3,000-gallon UST was reported to have leaked 1,700 gallons of gasoline. The tank was taken out of service upon discovery of the release. The service station was closed in 1985 and all fuel was removed from the tanks. In 1990, all the underground storage tanks (USTs) were removed and the impacted soils within the tank pit were removed to a depth of one foot below the groundwater table. Building 210 was demolished at an unknown date after the removal of the USTs. Currently, the site is asphalt-paved parking lot measuring approximately 350 feet by 150 feet and is used as a long-term parking lot for JBCA personnel. **Figure 2** presents the site layout.

Two Contamination Assessments were performed at AOC I (ST013); one in 1994 by Halliburton NUS and another in 1996 by Radian, Inc. The results of the Contamination Assessments indicated that soil and groundwater were impacted by the release of gasoline to the subsurface from a leaking UST and that "separate-phase hydrocarbons" (i.e., free product) were present at the site (Halliburton, 1994; Radian, 1996; AECOM, 2012b).

Long-term management (LTM) monitoring of groundwater has been performed at this site since 1994, and the results have been presented in LTM reports submitted to the SCDHEC.

In July 2002, a CAP consisting of an air sparge/soil vapor extraction (AS/SVE) system was placed into full operation at the site (Shaw, 2002). Based on a subsequent review of the effectiveness of the system and previous groundwater monitoring results, Earth Tech, Inc. (Earth Tech) recommended CAP modifications that included shutting down a portion of the AS/SVE system and installing a new section around monitoring well MW12-23 (Earth Tech, 2005). The CAP modifications were approved by SCDHEC on November 21, 2005.

The CAP modification activities were completed by June 13, 2006, and included installation of five air sparge wells (A11 through A15) and SVE conveyance piping, and tying the new installation to the existing AS/SVE system. A portion of the existing AS/SVE system (Field B, air sparge wells A7 through A10, and Field A, air sparge well A6) was shut down. The Underground Injection Control (UIC) Permit to Operate for the modified system was issued by SCDHEC on August 14, 2006 and the AS/SVE system was placed back on-line on August 24, 2006.

On April 22, 2007, lightning struck the AS/SVE system and severely damaged the control box relay. The system was repaired on June 15, 2007 and operated intermittently for the next 12 months. On June 30, 2008, the system was turned off because weekly operation and maintenance (O&M) could not be conducted due to contract delays. The system was restarted in December 2008 and remained operational through March 3, 2009. On March 3, 2009, the system was permanently shut down to allow for injection activities around monitoring well MW12-23. The AS/SVE system was abandoned in place in January 2015 (FPM, 2015b).

Two Oxygen Biochem Plus (OBC+®) injection events were conducted at the site, one in March 2009 and the other in July 2010. The injections were focused around the original "hot spot" groundwater monitoring well identified as MW12-23. Benzene and naphthalene concentrations in groundwater at that monitoring well have decreased following injections. However, consistent rebound of these contaminants occurred post-injection at monitoring wells MW12-23 and MW12-14, indicating that a residual contaminant source is likely present immediately upgradient of wells MW12-23 and MW12-14. The approximate location of the former UST basin is hydraulically upgradient of MW12-23. Groundwater flow patterns at the site have historically shown a radial pattern with a groundwater divide at or near the former UST basin (AECOM, 2012a).

A Limited Source Area (LSA) Investigation was conducted on April 17-18, 2012 to determine the location and concentration of contaminant mass suspected of being located upgradient of monitoring wells MW12-14 and MW12-23 (AECOM, 2012b). This investigation included advancing 23 soil borings and collecting soil samples for screening of organic vapors using a photoionization detector (PID). The LSA Investigation boring locations are shown on **Figure 3**. PID screening results ranged from 0.0 parts per million by volume (ppm/v) to 1,601 ppm/v. The results of the screening were used to select soil samples for laboratory analysis. A total of 15 soil samples were collected and submitted for analysis of BTEX and naphthalene by United States Environmental Protection Agency (USEPA) Method 8260B. Benzene was reported at concentrations that exceeded the SCDHEC RBSL of 3 micrograms per kilogram (µg/kg) in 14 of the 15 sampled locations. Toluene, ethylbenzene, and total xylenes were reported at concentrations in soils exceeding their RBSLs of 627 µg/kg, 1,551 µg/kg, and 13,010 µg/kg, respectively in 13 of the 15 sample locations. Naphthalene was reported at concentrations exceeding its RBSL of 47 µg/kg in 14 of the 15 sample locations. Based on the soil sampling results, the LSA Report concluded that additional corrective action to address groundwater contamination at MW12-14 and MW12-23 would be ineffective unless soil contamination is addressed. The LSA Report recommended that a CAP be established to remediate the impacted soils at the site combined with introduction of oxidant injections to reduce groundwater concentrations to below SCDHEC RBSLs (AECOM, 2012b).

LTM monitoring performed at the site since the completion of the LSA Investigation has shown that site groundwater contaminant concentrations remain in a relatively consistent range above the SCDHEC RBSLs. An SCDHEC letter dated 27 May 2016 approved the third quarter 2015 LTM Monitoring Report which recommended annual LTM monitoring sampling.

In accordance with the recommendations of the LSA Investigation, this CAP addresses potential residual soil contamination that may be present upgradient of, and in proximity to, groundwater monitoring wells MW12-14 and MW12-23, and also additional corrective action to address the remaining groundwater contamination.

1.4 CAP Organization

This CAP is organized into six sections, as described below:

- **Section 1** presents the introduction including authority, purpose and scope, site background, and CAP organization;
- **Section 2** presents the project organization including the responsibilities of key personnel, and presents the project schedule;
- **Section 3** presents the remediation plan including site background, proposed excavation and sampling, and Data Quality Objectives (DQOs);
- **Section 4** briefly discusses the Health and Safety Plan (HSP);
- **Section 5** discusses the CMI Schedule; and
- **Section 6** presents the references in this document.

The original Site-Specific Work Plan (SSWP) for Approved ACQAP with the site-specific QAPP (FPM, 2014) and annual updates to the SSWP for Approved ACQAP (FPM, 2015a, 2016)were submitted to the SCDHEC separately.

2 PROJECT ORGANIZATION

This section provides information on the project organization for this CAP, including identifying the roles and responsibilities of key personnel and the project schedule.

2.1 Roles and Responsibilities

The project organization and the responsibilities of key personnel are defined below.

AFCEC Contracting Officer (CO): The AFCEC CO is responsible for the contractual requirements of this contract. Any changes to the scope of work must be approved by the AFCEC CO, Ms. Leticia Walton.

AFCEC Contracting Officer's Representative (COR): The AFCEC COR is the technical point of contact for this contract. Questions regarding contract procedures and requirements are to be directed to the AFCEC COR, Mr. Anthony Williams.

Remedial Project Manager (RPM): The JBCA RPM is responsible for coordinating project activities and status with the AFCEC COR and communicating project activities with SCDHEC. The RPM for this project is Ms. Dana Holsclaw.

FPM AFCEC Program Manager: The FPM AFCEC Program Manager, Mr. Gaby Atik, PE, PMP, is responsible for ensuring that FPM complies with all the requirements of its contract with AFCEC for performance based remediation of certain sites at JBCA. The PM Project Manager for this contract reports directly to FPM's AFCEC Program Manager.

FPM Project Manager: The FPM Project Manager, Mr. Scott Saroff is responsible for properly staffing the project and is ultimately responsible for the technical direction and quality of the work performed by FPM personnel. He is responsible for establishing appropriate budgets and schedules, making available appropriate forms of training, and monitoring the performance of the staff. With Air Force approval, the Project Manager may talk with SCDHEC regarding methodologies and requirements. Specific responsibilities include:

- Providing the necessary personnel and equipment;
- Reviewing and approving Project Controlling Documents (i.e., CAP, ACQAP, SSWP, and UFP-QAPP Worksheets;
- Supporting the efforts of the Task Leader, Quality Assurance (QA) Officer (QAO), and Laboratory Manager(s) in all matters concerning the quality of work products; and
- Implementing effective response to corrective action requirements identified by any member of the project team.

FPM UST Rehabilitation Contractor Status and Lead Professional Engineer: FPM is a SCDHEC-approved Class 1 Rehabilitation Contractor (#UCC-0446), and Mr. Gaby Atik (South Carolina SC Professional Engineer (PE) #41468) is the designated lead engineer for FPM's UST rehabilitation projects in South Carolina.

FPM Site Lead: Mr. Niels van Hoesel is responsible for managing the PBR activities associated with this site. He is responsible for coordinating the deliverable submittals to the SCDHEC, and coordinating all field activities for this site. He is responsible for reporting all activities associated with this site to the Project and Program Managers, and coordinating field activities with the RPM.

FPM Field Superintendent/Health and Safety Officer: The FPM Field Superintendent, Mr. David Forse, will be responsible for the day-to-day management of field operations, and all aspects of health and safety in the field during implementation of the CAP. He is responsible for scheduling and planning the work activities of field staff, providing periodic reports on work progress, and reviewing the field logs and other forms of field documentation. He will work closely with the QAO to plan and schedule audits, if any, verify proper training of field personnel, and immediately communicate any situations that may affect the quality of work products. The Task Leader is responsible for field scheduling, and is responsible for technical quality of the work. Specific responsibilities include:

- Implementing the field components of this CAP;
- Coordinating all field activities, staging of wastes, disposal of remediation-derived wastes with the RPM, and restoration of the site.
- Overseeing and monitoring performance of staff;
- Planning the activities of and coordinating field personnel on specific assignments;
- Providing a liaison between the client, FPM field personnel, and any subcontractors;
- Managing subcontractors and vendors for this CAP;
- Reporting daily field activities to the Site Lead (Niels van Hoesel) and Project Manager (Scott Saroff); and
- Addressing corrective actions, as needed.

Laboratory Project Manager: The SGS Accutest Laboratories, Inc. (Accutest) of Orlando, Florida Project Manager, Ms. Jean Dent-Smith, is responsible for all aspects of laboratory operations related to this project. She acts as liaison between the project team and laboratory operations. Ms. Dent-Smith is responsible for providing laboratory deliverables according to schedule, and bears responsibility for verifying the technical accuracy and quality of the work. Specific responsibilities include:

- Providing appropriate documentation of laboratory methods;

- Coordinating overall project needs with the laboratory staff such that adequate equipment, methods, materials and analysts are available before a project is quoted or accepted;
- Implementing laboratory DQOs for the project;
- Reviewing laboratory project status and work with laboratory personnel such that due dates are met;
- Monitoring all client analytical and quality requirements, and reviewing project data packages for completeness and compliance;
- Maintaining the security of all laboratory records; and
- Implementing the appropriate corrective action for any QA/quality control (QC) deficiencies identified.

FPM QAO: The FPM QAO, Kevin Phillips, is responsible for implementation of the ACQAP. The Project Manager delegates to the QAO the authority to take any actions necessary to provide reliable and valid work and deliverables according to the ACQAP. The QAO has, by definition, a level of authority coequal to that of the Task Leader and Laboratory QA Manager. The QAO is responsible for developing and implementing procedures to appropriately document all project activities to provide specific means of measuring conformance to specifications, managing the corrective actions program, and providing periodic reports to management. Specific responsibilities include:

- Developing, documenting, and carrying out QA activities such that appropriate QC measures are being carried out and documented;
- Verifying that all records related to QA are documented and maintained securely and retrievably;
- Conducting periodic performance audits and/or surveillance to measure conformance to specifications;
- Preparing periodic quality reports and QA sections of final reports;
- Verifying that corrective actions are carried out and documented in a way that precludes future occurrences;
- Reviewing and approving training records and purchasing actions; and
- Acquiring and maintaining required certifications, and managing performance evaluation tests.

Technicians and Analysts: Field staff and analysts are responsible for executing their work assignments according to documented procedures and for the immediate identification of any conditions adverse to the quality performance of the work or work products. They are responsible for acquainting themselves with the technical requirements of any work assigned and seeking training or guidance as necessary to comply with those requirements. They are responsible for documenting their activities according to applicable sections of the SCDHEC

Programmatic QAPP (SCDHEC, 2015) and the ACQAP (FPM, 2015a) and reviewing their own work and the work of others presented to them for peer review. They will immediately cause work to cease on any activity that in their judgment does not meet applicable quality and safety standards. They will appropriately document and report such conditions to management and will be active in the resolution of any such conditions. Specific responsibilities include the following:

- Arranging for, and conducting, excavation of the contaminated soils and treating groundwater as specified in this CAP (excavation will be conducted by a competent FPM excavator operator);
- Verifying that all work is performed according to the applicable specifications;
- Documenting that QC measures are being carried out;
- Managing the quality of work and work products; and
- Communicating QA and safety concerns to the Field Superintendent, Site Lead, and Project Manager.

Subcontractors: The following subcontractors have been identified for the performance of the scope of work (SOW).

Well Abandonment and Installation: Terry Environmental, Inc., a South Carolina-licensed well driller will provide the services needed for well abandonment, well installation, and ORC and if needed, oxidant injections. In this role, they will provide all of the equipment, materials, and manpower to aid FPM personnel in the completion of the SOW as it pertains to monitoring well abandonment, monitoring well re-installation, and oxidant injection activities.

Contaminated Soil Transportation: TLS Trucking, a South Carolina-licensed solid waste transporter will transport the contaminated soils from the base to the disposal facility noted below. In this role they will provide all trucks and operators necessary to transport all contaminated soils generated during the SOW from the base to the disposal facility.

Soil Disposal: Oak Ridge Landfill, Waste Management (WM), Dorchester, South Carolina, a South Carolina-licensed solid waste disposal facility. WM Oak Ridge has been selected as the disposal landfill based on its SCDHEC license to receive wastes such as those from the site and its proximity to JBCA. In this role, they will provide all of the equipment, materials, and manpower to facilitate the appropriate disposal of all excavated soil and remediation-derived waste (RDW) generated during performance of this CAP.

Laboratory Analytical Services: SGS Accutest, SCDHEC Certification #96038001, of Orlando, Florida. Accutest was selected through a competitive bid process to serve as the analytical laboratory for this project. SGS Accutest possesses the required South Carolina Analytical Laboratory Certification, and has a strong work history with FPM. In this role, they will provide

all of the equipment, materials, and manpower to perform the required laboratory analytical services inclusive of all QA/QC procedures and documentation. The Laboratory Project Manager, Ms. Jean Dent-Smith, is responsible for all aspects of laboratory operations related to this project.

Backfill Materials: Clean backfill materials will come from an approved source and transportation will be handled by TLS Trucking. Prior to use as backfill, the material will be tested at its source and approved by JBCA prior to delivery to the site. The trucking company will provide all labor, materials, and equipment necessary to obtain and transport the backfill materials to the project site.

Surveying: George A.Z. Johnson Jr. Inc., a South Carolina-licensed surveyor, will provide all equipment and labor to perform the certain surveying services for the CAP, including surveying monitoring well locations (re-installed existing wells MW12-14 and MW12-23) horizontally and vertically with respect to South Carolina State Plane Coordinates and the North American Vertical Datum of 1989 (NAVD '89), respectively. The extent of the excavation(s) and the location of the infiltration galleries will be surveyed by FPM personnel using a Global Position System (GPS) Trimble® instrument or by the licensed surveyor.

Site restoration (asphalt installation): Logan Construction has been selected for site restoration. After all backfill activities are performed by FPM, the site's surface will be restored to its historical function as a parking lot and therefore new blacktop will be installed.

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3 REMEDIATION PLAN

3.1 CMI Activities

The specific tasks of this CAP include the following:

- Conduct pre-CMI soil sampling activities to refine the extent of soil contamination excavation, and report the final excavation plan to the SCDHEC in a Technical Memorandum;
- Conduct a soil excavation to remove the contaminated unsaturated soils impacting groundwater;
- Conduct a chemical oxygen release compound (ORC®) injection around monitoring well MW12-22R;
- Properly abandon monitoring wells within the planned excavation area (MW12-14, MW12-15, and MW12-23) by a South Carolina certified well driller in accordance with the South Carolina Well Standards R.61-71; and
- Reinstallation of monitoring wells MW12-14R and MW12-23R by a South Carolina certified well driller in accordance with the South Carolina Well Standards R.61-71.

Plan A

- Upon SCDHEC's approval of the final excavation plan, which is included in the technical memorandum that summarizes the pre-CMI soil sampling activities, complete the soil excavation to remove contaminated unsaturated soil impacting groundwater.
- Collect confirmatory post-excavation soil samples from the excavation side walls and the bottom of the excavation (unless below the water table) and analyze for benzene, toluene, ethylbenzene and total xylenes (BTEX) and naphthalene to document residual COC concentrations.
- Disperse a chemical oxygen release compound (ORC®) in the excavation to remediate residual groundwater contamination.
- Install injection galleries (e.g., horizontal wells set 0.5 feet below the water table) within the excavation, backfill the excavation, and restore the area to the requirements of JBCA.
- Install replacement monitoring wells MW12-14R and MW12-23R;
- Inject additional ORC® in the vicinity of MW12-22R to depths of 5-15 ft below grade by direct-push methods at 10 locations;
- Prepare and submit a Construction Completion Report (CCR) to the SCDHEC documenting field activities and laboratory analytical results of soil samples collected during excavation activities;
- Conduct two performance monitoring events: Collect groundwater samples from monitoring wells MW12-14R, MW12-17, MW12-22R, MW12-23R, and MW12-25 for site groundwater

COCs, BTEX and naphthalene, to evaluate remedial action effectiveness after approximately 30 days and 90 days of completing the CMI contaminated soils removal and groundwater treatment activities.

- Submit CMI Progress Report to the SCDHEC documenting the performance monitoring results.
- Thereafter, conduct quarterly LTM events and prepare and submit semi-annual LTM reports;

Plan A Contingency (if needed)

- If after the two performance monitoring events, the site groundwater COCs have not achieved RBSLs, evaluate injecting additional ORC into the infiltration galleries. If concentrations show significantly decreasing trends, continued monitoring will be performed. If concentrations show decreasing trends in most wells but not all, infiltration galleries near wells without this trend may be targeted for additional injections. If most wells show a limited decreasing trend, all injection galleries near these wells may be targeted for additional injections at higher concentrations or larger injection volumes, etc. All this is part of the evaluation process.
- Continue to conduct quarterly LTM monitoring including any Plan A contingency implementation activities.

Plan B Contingency (if needed)

- If two consecutive quarterly sampling events demonstrate that site COCs concentrations have not achieved RBSLs, FPM will evaluate injecting another chemical oxidant solution into the infiltration galleries. In this scenario, it is believed that the selected oxidant is not suitable for the site and corrective actions (Plan A contingency) have not had the desired effect. A different oxidant is the Plan B contingency. The LTM monitoring reports will report all Plan B Contingency activities conducted.
- FPM will recommend NFA in the applicable CMI progress/LTM report when two consecutive quarterly sampling events demonstrate that site COCs concentrations remain have achieved SCDHEC RBSLs.
- Upon SCDHEC's approval of NFA, properly abandon the site groundwater monitoring wells and submit the well abandonment report to the Air Force and SCDHEC to document SC.

3.2 Proposed Pre-Design Soil Borings

The extent of the target soil excavation will be verified by pre-design (or pre-CMI) soil boring sampling. As shown in **Figure 5**, 18 pre-CMI borings are currently planned, which are based on a 20-ft step-out from petroleum impacted locations exceeding RBSLs reported in the 2012 LSA investigation (AECOM, 2012b). This sampling will consist of obtaining continuous soil samples from 0-5 ft with a 5-foot long Macrocore® or equivalent sampler (closed tube sampling device).

This size sampler has been selected due to the historical groundwater depth of approximately 6-7 ft bgs. It assures that unsaturated soil is screened to avoid moisture interference with screening.

At each boring location, field observations (obvious odors, staining, etc.) will be recorded and the soil will be screened with a photoionization detector (PID) equipped with a 10.6-EV lamp to measure volatile organic vapors/gases in parts per million by volume (ppm/v) of air. After a representative soil sample is added to sealable plastic bag, the bag is tented and left to sit for approximately 5 minutes to equilibrate head space. The probe tip of the PID is then inserted into the sealable plastic bag and the vapor concentration in the headspace of the bag is measured and recorded. Evidence of contamination will be used to determine the extent of soil to be removed, and to complete the design before its implementation.

Based on the data from the 2012 LSA Investigation (AECOM, 2012b), a target level of 10 ppm/v as measured by the PID will be used to define the excavation limits. If 10 ppm/v is exceeded, additional step out soil boring locations will be installed at 20-foot spacing, similar to the spacing used in the 2012 LSA investigation. Step out sampling will continue until all exterior soil boring locations have met the screening criteria of a PID reading of 10 ppm/v. Additional soil boring locations may also be installed based on field observations. These will be determined by field personnel during the actual field work. Once the screening results of the pre-CMI soil borings are available, they will be reviewed and an updated excavation plan will be submitted to the SCDHEC in a Technical Memorandum.

3.3 Plan A Activities

3.3.1 Contaminated Soil Excavation

Soil excavation will be completed to remove source materials which are suspected of maintaining high COC concentrations in groundwater. **Figures 5** and **6** shows the preliminary excavation extent which may be revised based on the pre-CMI soil borings. The final excavation plan, as noted above, will be submitted to the SCDHEC for approval. The plan will include the pre-CMI soil boring results and the final excavation extent in a Technical Memorandum to be submitted to SCDHEC for approval.

FPM proposed to perform the soil excavation in a row design. The excavation will be started at the northern end of the site (near MW12-23) and be roughly 30 feet in the north-south axis (approximately the reach of the excavator). The excavation will expand to the east and west until soils meet screening criteria, which completed the first row. Then the excavator is moved south for another 30 ft (the excavator's reach) and the excavation expands east and west until soils meet screening criteria, which completed the second row. This continues until the southern wall of the excavation meets screening criteria. This row design is proposed because it allows the excavator to drive back and forth on the parking lot pavement and it allows the dump trucks to use the parking lot for entry, loading and leaving without approaching the excavation too closely and minimizes contamination of the exterior of the dump trucks.

FPM proposes to remove contaminated soils to a depth of approximately 7 feet below ground surface (bgs), which is the approximate low historical groundwater depth measured it monitoring wells MW12-14 and MW12-23. The excavation sidewalls will be stabilized during excavation by either sheet piles or by banking the walls, which will be determined after the final excavation limits are established.

The excavation will be dewatered to enhance excavation efficiency and reduce the amount of water in excavated soils. Excavation water will be pumped to a fractionation tank for subsequent characterization and disposal. The disposal method will be based on the level of contamination observed/reported in the water. The preferred method of disposal will be releasing this water to the sanitary sewer system if the levels of contaminants are below the discharge criteria specified by the North Charleston Sewer District and JBCA. Excavation water may be run through a filter prior to storage in the fractionation tank.

All excavated soils will be screened with a calibrated PID. Shallow soils which do not exhibit signs of contamination (staining, discoloration, etc.) or have PID readings below 10 ppm/v will be stockpiled at the site for reuse as excavation backfill. This volume is estimated at approximately 500 cubic yards. Stock piles will be created of maximally 250 cubic yards and one grab sample from each stock pile will be collected and analyzed for BTEX, naphthalene, methyl tertiary butyl ether (MTBE) via USEPA Method SW8260B, and a composite sample (consisting of five grab samples) from each stock pile will be analyzed for PAHs (SW8270D) and total lead (SW6010C). The clean soils will be stockpiled on-site on polyethylene sheeting, surrounded by a berm and covered until they are placed back into the excavation. Contaminated soils, which are any soils that have signs of contamination (staining, discoloration, PID readings above 10 ppb/v) will be direct loaded into trucks and transported to the WM Landfill.

The excavation will stop when PID readings at the sidewalls are below the target level of 10 ppm/v. The bottom of the excavation will be where PID readings fall below 10 ppm/v, or the 7-foot seasonal-low groundwater depth limit, whichever is shallower.

Confirmatory soil samples will be collected at the excavation area as shown on **Figure 6**. Nineteen confirmatory samples are currently planned at the preliminary excavation circumference at a spacing of approximately 20 ft between sampling locations. Confirmatory samples will be analyzed for BTEX, naphthalene, MTBE (USEPA Method SW8260B), PAHs (USEPA Method SW8270D), and total lead (SW6010C). All soil analytical results will be compared to RBSLs (as applicable) provided in Table D4 in the 2016 Programmatic QAPP for the UST Management Division (SCDHEC, February 2016). **Appendix A** contains the completed SCDHEC Site-Specific Work Plan form for this action.

The oxygen release compound ORC-Advanced® will be dispersed into the excavation to contact groundwater. **Appendix B** provides documentation of the suitability of these chemicals to remediate site contaminants. The selected material will enhance biological degradation by providing necessary nutrients and chemical components to address residual soil and groundwater

contamination by contaminant absorption followed by treatment, which is accomplished through biodegradation of the absorbed contaminants. This form of treatment is non-toxic and has no adverse impacts on soil properties or groundwater quality. A UIC permit has been prepared and is included in **Appendix C**.

Injection galleries are proposed for installation prior to backfilling, which can be used for future application of oxidants. The preliminary layout of the injection galleries is shown in **Figure 6**. This layout was selected as a compromise between groundwater flow direction and preliminary excavation extent. The first foot of backfill will consist of ¾-inch crushed stone to allow for dispersion of future oxidant injections in the injection gallery across the entire excavation area. Because of this higher permeability, injection galleries are proposed with a maximum separation distance of 50 ft. Injection galleries consist of a horizontal well comprised of 2-inch inside diameter (ID) Schedule 80 polyvinyl chloride (PVC), 0.040-inch slotted screen will be placed below the historical water table at a depth of 6.5 feet (or at 0.5 feet from the bottom of the excavation where it is shallower). The galleries will be completed by two-inch ID riser to the parking lot surface with a lockable cap, and wellbox. **Figure 7** shows the typical detail for a horizontal injection well.

After the excavation is backfilled, the area will be resurfaced in a fashion similar to the current surface conditions (e.g., parking lot asphalt). Monitoring wells MW12-14 and MW12-23 will then be re-installed as MW12-14R and MW12-23R and surveyed for location and top of casing by the licensed surveyor. The petroleum-impacted soils, with an estimated volume of 1,200 cubic yards, will be removed from the site by a licensed waste hauler and disposed of at the WM Oak Ridge Landfill, a licensed disposal facility. Contaminated soils will be directly loaded onto trucks for transport to the disposal facility. **Figure 9** depicts the transportation route for trucks into and out of the site. FPM or the licensed surveyor will survey the extent of the excavation and location of the infiltration galleries for use in the CCR and CMI progress reports.

The oxygen release compound ORC-Advanced® injection program is proposed in the vicinity of MW12-22R to address elevated levels of BTEX and naphthalene at this location. A total of ten injection points are proposed by installation of Geoprobe® or equivalent at the locations shown on **Figure 8**. ORC-Advanced® or equivalent solution will be injected from 5 to 15 feet bgs using direct push equipment.

3.3.2 Plan A Contingency

If after the second performance monitoring event site groundwater COCs have not reached RBSL levels, FPM will evaluate additional ORC® solution injections into the injection galleries, and continuation of quarterly LTM monitoring events. The volume will be based on the performance monitoring analytical results.

3.4 Plan B Contingency

If after the fourth quarterly LTM monitoring event site groundwater COCs have not reached RBSL levels, FPM will evaluate injecting a different chemical oxidation solution into the injection galleries, and continuation of quarterly LTM monitoring events. Chemical oxidation injections via the infiltration galleries will continue until quarterly LTM monitoring demonstrates that COCs are below RBSLs for two consecutive sampling events.

3.5 Other Site Activities

3.5.1 Replacement Monitoring Well and New Well Installations

Replacement groundwater monitoring wells MW12-14R and MW12-23R and new monitoring well MW12-25 will be flush mounted and installed to a depth of approximately 12 feet to account for groundwater level fluctuation. The well will be constructed of 2-inch ID PVC casing with a 0.01-inch slotted, 10-feet long screen. Well installation and development will be conducted following procedures described in the ACQAP (FPM, 2015a) and performed by a by a South Carolina certified well driller.

All new monitoring well locations and tops of casing will be surveyed horizontally and vertically using state plane coordinates North American Datum (NAVD) 1988, U.S. Survey Geological Survey elevations by the licensed surveyor. The soil boring locations will be surveyed by FPM personnel using a Trimble® GPS Instrument.

Purged groundwater and decontamination water for the new monitoring wells will be collected in 5-gallon buckets with lids and transported to the existing Investigatory-Derive Waste (IDW)/RDW holding tank designated for FPM use near Building 692. At the end of each contract year, one sample will be collected of IDW/RDW water in the holding tank for waste characterization purposes. After the analytical results are received, a brief letter report or email will be prepared and submitted to JBCA for review and approval, comparing the analytical results to the North Charleston Sewer District (NCSD) pretreatment limits or disposed of using a vacuum truck for disposal at a licensed facility. If the results are below the pretreatment limits, and if approval is obtained from JBCA and NCSD, IDW/RDW water may be disposed of to the JBCA sanitary sewer system through the manhole located behind Building 692; otherwise IDW water will be disposed of off-site.

Drill cuttings will be placed into drums, tested for disposal parameters (if and as required by WM Oakridge Landfill), and transported to the storage area at Building 692. The soil drums will be transported by TLS Trucking for disposal at the WM Oakridge Landfill within 90 days of collection. The manifests will be signed by a JBCA representative.

The North Charleston Sewer District Pretreatment Program Limits are provided in **Appendix D**.

3.5.2 Confirmatory Soil Sampling

Confirmatory soil samples will be collected at the excavation area as shown on **Figure 6**. Nineteen confirmatory samples are currently planned at the preliminary excavation circumference at a spacing of approximately 20 ft between sampling locations. Additional confirmatory soil samples will be collected from the bottom of the excavation where the excavation depth did not reach the water table. Confirmatory samples will be analyzed for BTEX, naphthalene, MTBE (USEPA Method SW8260B), PAHs (USEPA Method SW8270D), and total lead (SW6010C). All soil analytical results will be compared to RBSLs (as applicable) provided in Table D4 in the 2016 Programmatic QAPP for the UST Management Division (SCDHEC, February 2016).

3.5.3 Performance Groundwater Monitoring Events

Groundwater will be monitored quarterly at the site wells post excavation and groundwater treatment, and reported in the CMI Progress Report. Groundwater field geochemistry testing and sampling will be conducted in accordance with the LTM sampling program currently approved by SCDHEC. Updated Section B of the ACQAP for this monitoring is included in **Appendix E**.

3.5.4 Data Quality Objectives

The data to be collected during this field work include field data and definitive laboratory data. Field data includes data produced by rapid field screening equipment. These devices are generally less precise than standard analytical methods and provide qualitative data. This type of data will be generated during soil screening with a PID during excavation activities.

Definitive laboratory data is produced using standard USEPA or other reference methods in an off-site laboratory. The data are analyte-specific and have the standardized QC and documentation requirements necessary to verify all results. Definitive data are not restricted in their use unless QC problems are encountered which may require the data to be qualified. This type of data will be generated to identify the type and quantify the COC concentrations.

A QA/QC program will be implemented to meet the above objectives. Sample collection data quality will be controlled through the use of standard collection methods and field logbooks. Selected field sampling procedures are discussed in **Section 3.6** of this CAP and are also provided in Appendix C of the ACQAP (FPM, 2015a). Adherence to these field procedures will help sample representativeness and minimize the potential for sample contamination.

3.5.5 Soil Sample Collection Procedures

Sample locations and the types and number of samples to be collected for each parameter are described in **Section 3.3.1** of this CAP. Sample handling, labeling, and identification procedures are described below. Equipment decontamination will be conducted using procedures that are

described in the SCDHEC Programmatic QAPP (SCDHEC, 2015) and the ACQAP (FPM, 2015a). QA/QC requirements are also provided in the Programmatic QAPP (SCDHEC, 2015) and the ACQAP (FPM, 2015a).

3.5.6 Sample Management

The Task Leader is responsible for seeing that samples are handled in accordance with Section B3 of the ACQAP (FPM, 2015a). This details that sample containers will be wiped clean of all sample residue and wrapped in protective packing material (bubble wrap), taped, bagged and placed upright in an iced cooler. The cooler will be filled with additional packing material to prevent damage, a COC will be included in each cooler in a plastic bag and the cooler lid will be taped closed with a custody seal. Coolers will be hand delivered or shipped by overnight express carrier to the analytical laboratory to meet specific holding times.

3.5.7 Sample Labeling

Once samples are collected, each sample container will be affixed with a non-removable (even when wet) label. The following information will be written in permanent ink on each sample label:

- Site name
- Unique sample identification
- Sample date/time
- Sampler's initials
- Sample preservation
- Analysis required

3.5.8 Sample Identification

Identification numbers will trace each sample back to specific sites, sample location, sample type, and the round of sampling at a sample location. An identification number is designed to prevent misidentification and will be recorded on all field record documentation. The unique numbers will be used to identify the sample during collection, storage, analysis, data review, and reporting.

3.5.9 Evaluation of Results

At the conclusion of field activities, FPM will compile and evaluate the results. Field and analytical data will be reduced into narrative, tabular, and graphic forms consistent with their intended use. Field records will be maintained in secure files and copies will be distributed according to the requirements of the contract.

Analytical data will be subject to assessment and validation procedures as described in Sections B and C of the ACQAP (FPM, 2015a). Analytical data will be processed for submission to the Air Force Environmental Resources Program Information Management System (ERPIMS).

The data will be compared to the SCDHEC RBSLs. Once two consecutive PM and/or LTM events indicate COCs below their respective RBSLs, SCDHEC will be petitioned for SC. If groundwater COCs are not below RBSLs at all monitoring wells after two consecutive sampling events, additional monitoring events will be conducted to target only the well(s) above RBSLs to monitor trends.

3.5.10 Recordkeeping

Recordkeeping will be performed in accordance with the ACQAP (FPM, 2015a).

3.5.11 Reporting

The results of the field data collection and the results of the laboratory analytical data will be compiled, summarized, and analyzed in the CCR, CMI Progress Report, and LTM reports. The first report will summarize excavation activities along with the numbers, types, locations, results of sampling activities. Additional reports will summarize the numbers, types, locations, and results of sampling activities, and when appropriate, develop evidence that supports NFA based on current and historical site data.

3.6 Performance Model

The CAP performance model is presented in **Figure 10**. It presents the groundwater monitoring results and expected results for the most contaminated groundwater at the site (at monitoring well MW12-14). It is expected that when the most contaminated groundwater at the site follows the performance model and meets RBSLs, all other monitoring wells with less contaminated groundwater will also meet RBSLs. Due to the planned soil excavation which removes the source of groundwater contamination, groundwater benzene and naphthalene concentrations are expected to decrease. In addition, the application of an oxygen release compound (ORC-Advanced®) will assist in rapid breakdown of COCs. It is expected that COC concentrations will meet RBSLs after 90 days, but a greater timeframe is built into the performance model as a buffer. Quarterly LTM sampling after performance monitoring will confirm these trends. Plan A, Plan A Contingency, and Plan B Contingency presented in the model are discussed in Sections 3.3 and 3.4 of this CAP.

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4 HEALTH AND SAFETY PLAN (HSP)

Activities described herein will be completed in accordance to an updated Site-Specific Health and Safety Plan (HSP) previously prepared for JBCA (FPM, 2013). The HSP will include the site-specific SOW, hazard assessment, general health and safety requirements, protective equipment, contamination control procedures, and job safety analysis. FPM employees are responsible for following the procedures described in the HSP and for exercising the utmost care and good judgment in protecting their own health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the Task Leader and the Project Manager. In the event of an immediately dangerous or life-threatening situation, the employee always has "stop work" authority.

All field staff (FPM and subcontractor personnel) will read and review the updated HSP prior to mobilizing to the site. A copy of the updated HSP will be available on site during all field activities.

FPM's Field Superintendent will be responsible for FPM and subcontractor compliance while working at the site. He will facilitate tailgate health and safety meetings at the site prior to the start of all daily field work.

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5 PROJECT SCHEDULE

The project schedule is provided below. It tracks to the CAP Performance Model presented in **Figure 10**. Actual project progress will be monitored and compared with planned progress. Updates to the project schedule, if needed, will be issued to all applicable parties.

Task	Schedule
Conduct of pre-CMI contaminated soil delineation soil boring and soil screening, and reporting, and monitoring well abandonment.	Within four weeks of receipt of SCDHEC approval of the CAP, the pre-CMI soil boring investigation will initiated. Within two weeks of completing the field work, the final Excavation Plan will be submitted in Technical Memorandum to the SCDHEC for approval.
Commencement of Corrective Measure Activities	Within four weeks of receipt of SCDHEC approval of the final excavation plan Technical Memorandum.
Completion of Corrective Measure Activities	Within six weeks of commencement of CAP Activities.
Construction Completion Report (CCR)	Within two months after completion of Remedial Activities
Performance Monitoring – 1st Round	Conduct performance monitoring within 30 days of soil excavation and groundwater treatment.
Performance Monitoring – 2nd Round	Conduct performance monitoring within 90 days of soil excavation and groundwater treatment.
CMI Progress Report	Two months after completion of performance monitoring, submit the CMI Progress Report to SCDHEC for approval.
Quarterly LTM Events and Reporting	Within 90 days after the 2nd Round of Performance Monitoring conduct LTM Monitoring Event, and within 60 days after that, submit the LTM Monitoring Report to SCDHEC. Continue quarterly LTM monitoring events and reporting until the LTM Monitoring Report NFA recommendation is approved by SCDHEC.
Plan A Contingency Implementation (if needed)	If after the first two quarterly LTM monitoring events post soil excavation and groundwater treatment site groundwater COCs have not reached RBSL levels, additional ORC injections will be evaluated, and continuation of quarterly LTM monitoring events.
Plan B Implementation	If after the fourth quarterly LTM monitoring event site groundwater COCs have not reached RBSL levels, injection of a different chemical oxidation solution into the injection galleries will be evaluated, and continue with quarterly LTM monitoring events. Continue chemical oxidation injections via the infiltration galleries until quarterly LTM monitoring demonstrates COCs below RBSLs for two

	consecutive sampling rounds.
Submit Infiltration Galleries Decommissioning and Monitoring Well Abandonment Work Plan	Upon SCDHEC approval of LTM Monitoring Report NFA for the site, submit the infiltration galleries and monitoring well abandonment work plan to the SCDHEC for approval, and within 60 days of SCDHEC approval implement the work plan.
Submit Infiltration Galleries Decommissioning and Monitoring Well Abandonment Report	Within 60 days of completing the field activities, submit to the SCDHEC, the infiltration gallery decommissioning and monitoring well abandonment report to demonstrate SC.

6 REFERENCES

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Carolina Department of Health and Environmental Control, Columbia, South Carolina, February.

FIGURES

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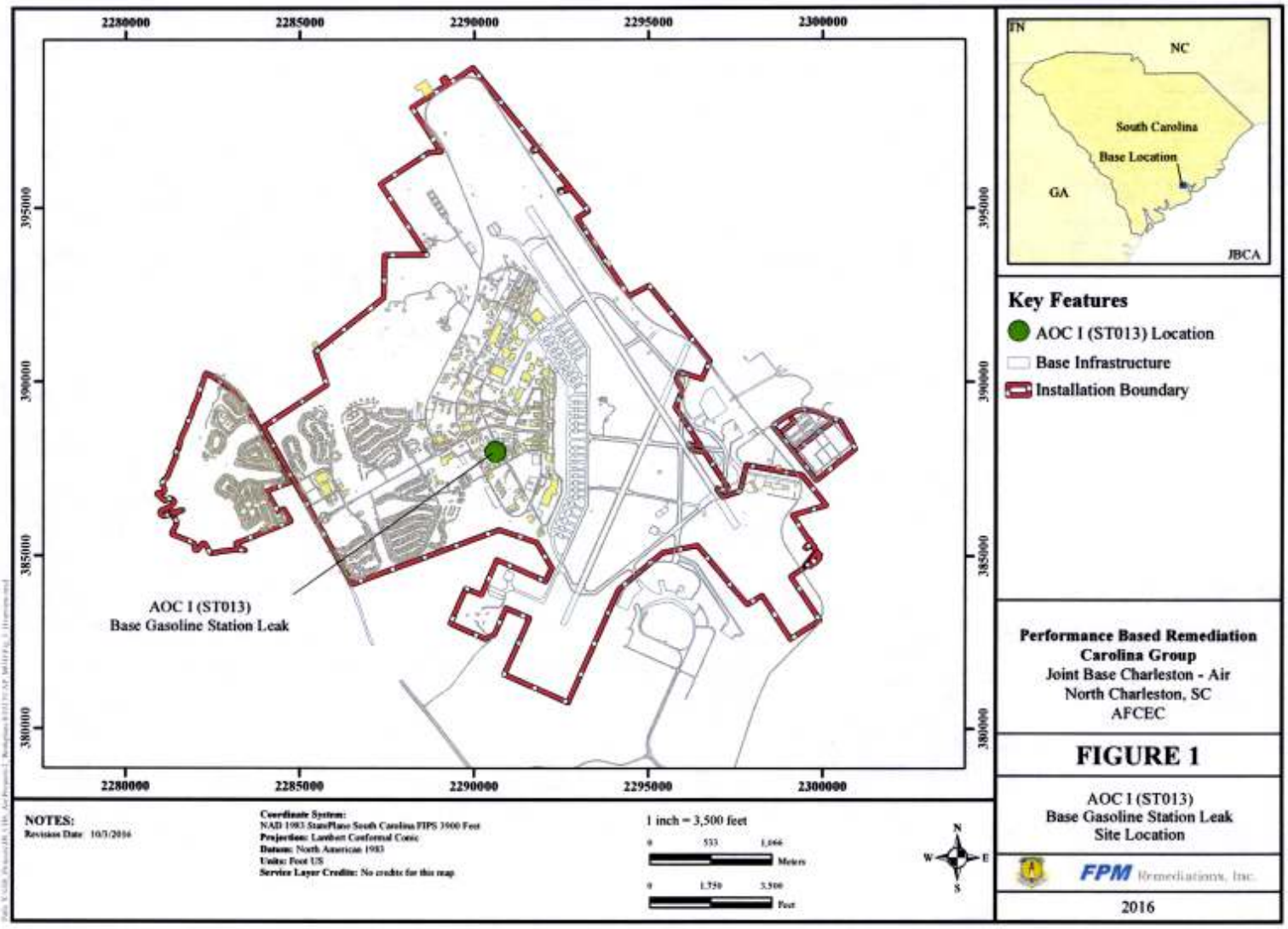
2280000
2285000
2290000
2295000
2300000
395000
390000
385000
380000
AOC I (ST013)
Base Gasoline Station Leak
TN
NC
South Carolina
Base Location
GA
JBCA
Key Features
AOC I (ST013) Location
Base Infrastructure
Installation Boundary
NOTES:
Revision Date: 10/3/2016
Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credit: No credits for this map
1 inch = 3,500 feet
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Meters
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North Charleston, SC
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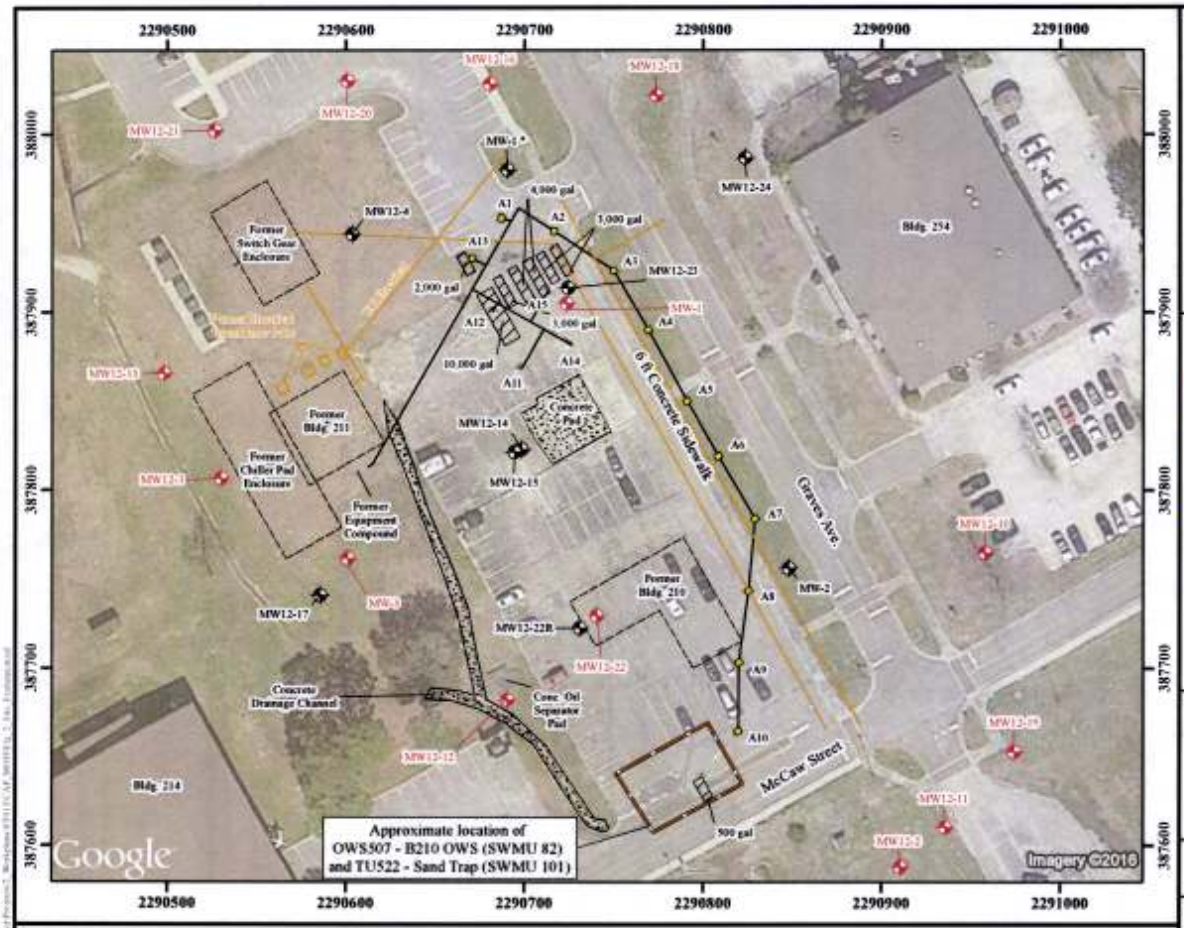
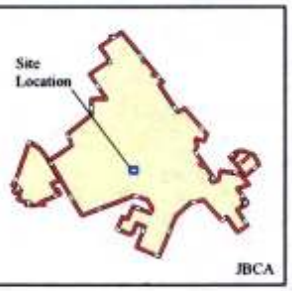
FIGURE 1
AOC I (ST013)
Base Gasoline Station Leak
Site Location
FPM Remediations, Inc.
2016





Key Features

- Monitoring Well
- Abandoned Monitoring Well
- Underground Utility Line
- Approximate SWMU Location
- Former UST
- SVE Well Vault
- Vault Piping (Abandoned in Place)
- Demolished Facility
- Former Concrete Drainage Channel
- Former Concrete Pad

NOTES:

1. * Labeled MW12-4 in contaminant assessment report (December 1997, Figure 5.1-2).
2. Location of MW12-11 is approximate because it extends outside the drawing boundaries.
3. Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map

1 inch = 80 feet

0 12 24 Meters

0 40 80 Feet

N W E S

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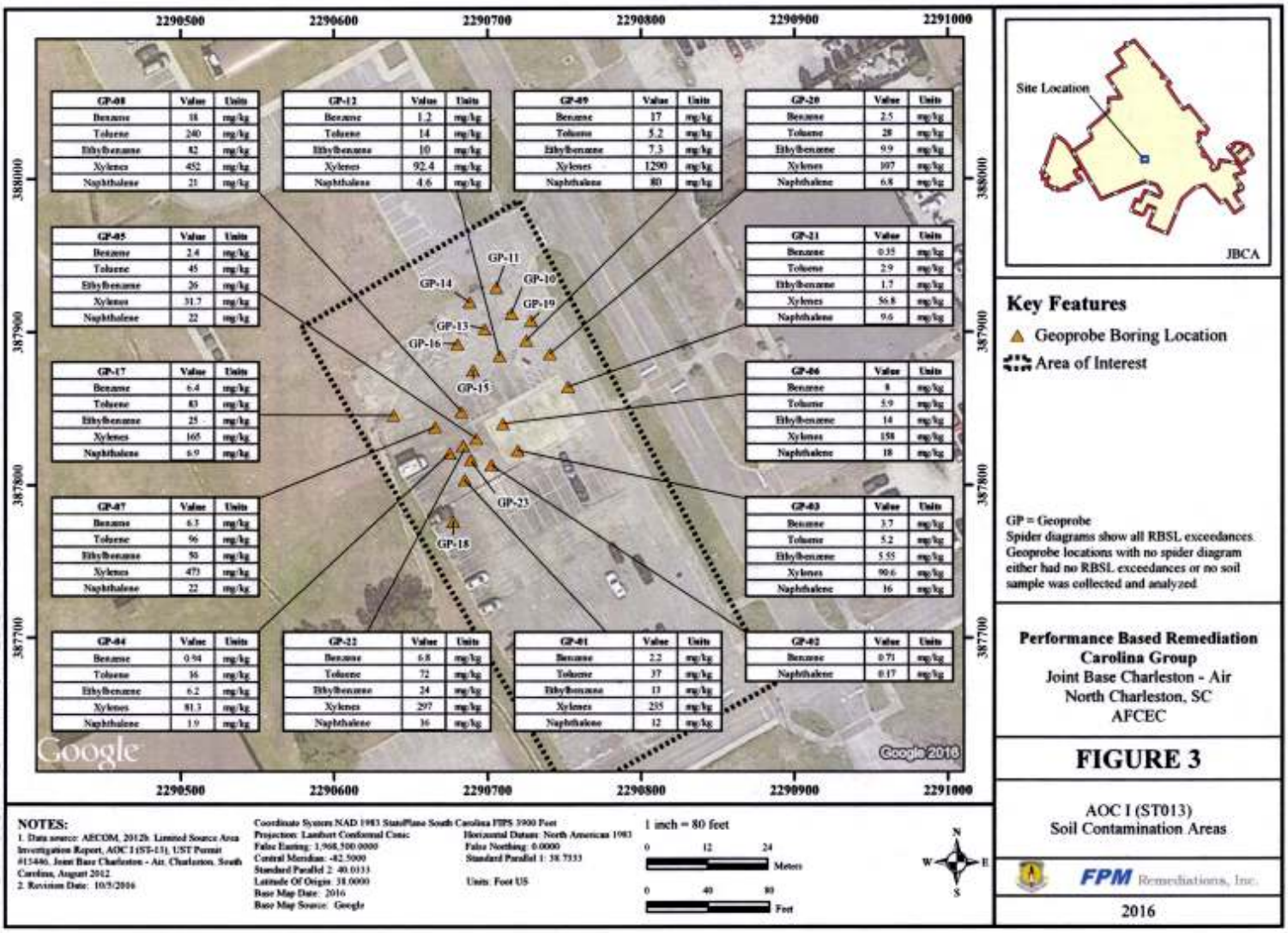
North Charleston, SC
AFCEC

FIGURE 2

AOC I (ST013)
Base Gasoline Station Leak
Historic Site Features

FPM Remediations, Inc.

2016



Key Features

- Geoprobe Boring Location
- Area of Interest

GP = Geoprobe
Spider diagrams show all RBSL exceedances. Geoprobe locations with no spider diagram either had no RBSL exceedances or no soil sample was collected and analyzed.

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FIGURE 3

AOC I (ST013)
Soil Contamination Areas

FPM Remediations, Inc.

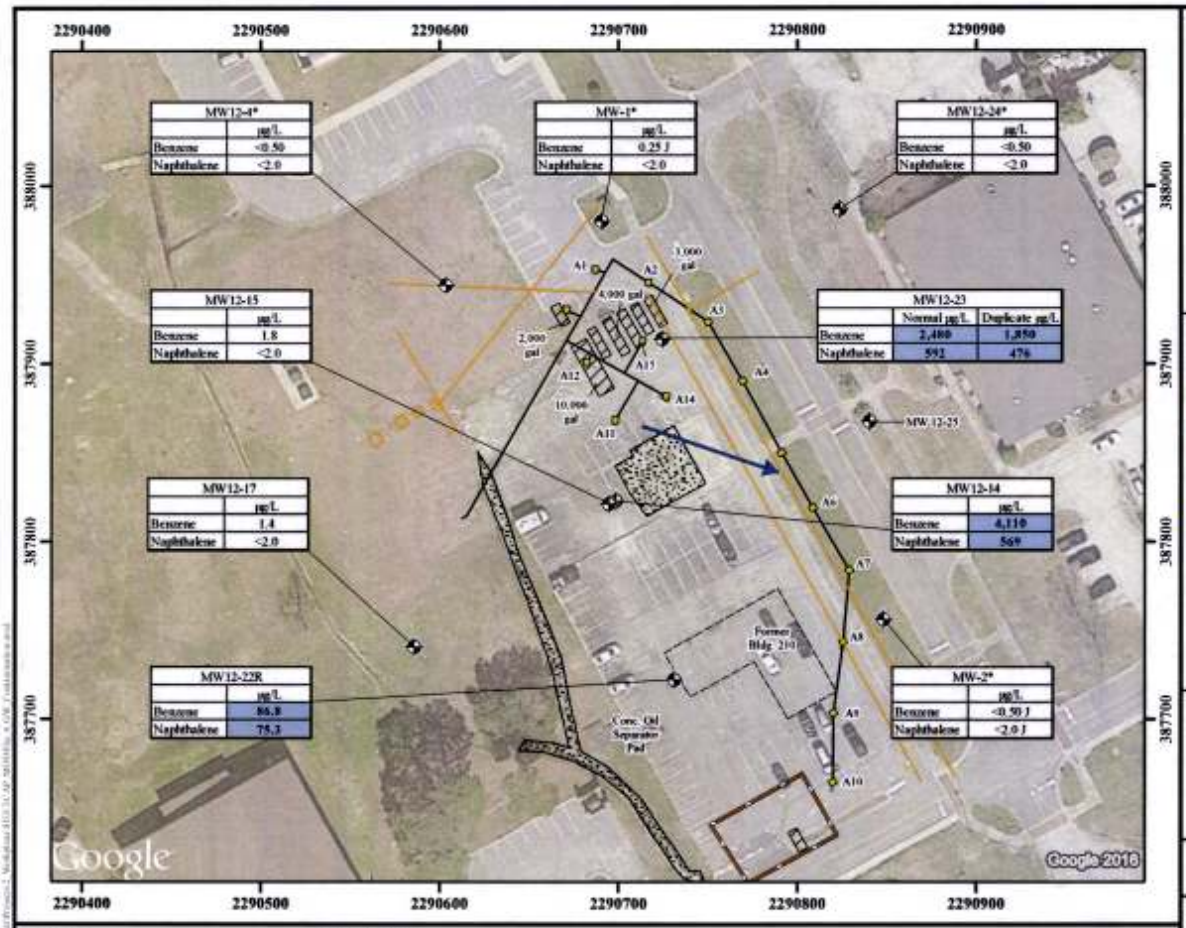
2016

NOTES:
1. Data source: AECOM, 2012b. Limited Source Area Investigation Report, AOC I (ST-13), UST Permit #13446, Joint Base Charleston - Air, Charleston, South Carolina, August 2012.
2. Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
False Easting: 1,968,500.0000
Central Meridian: -82.5000
Standard Parallel 2: 40.0333
Latitude Of Origin: 31.0000
Base Map Date: 2016
Base Map Source: Google
Horizontal Datum: North American 1983
False Northing: 0.0000
Standard Parallel 1: 38.7333
Units: Foot US

1 inch = 80 feet
0 12 24 Meters
0 40 80 Feet

N W E S



Key Features

- Existing Monitoring Well
- Groundwater Flow Direction
- Underground Utility Line
- Approximate SWMU Location
- Former UST
- Former SVE Well Vault
- Former Vault Piping
- Demolished Facility
- Concrete Drainage Channel
- Concrete Pad

*Annually sampled monitoring well, October 2014 result

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FIGURE 4

AOC I (ST013)
Base Gasoline Station Leak
Groundwater Contamination

FPM Remediations, Inc.

2016

NOTES:

1. Concentrations that are exceedances of the regulatory limit are values greater than 5 MCL for Benzene and 25 ug/L RBSL for Naphthalene.
2. Bold and shading indicates above RBSL or MCL.
3. See table 3 for data qualifier definition.
4. Monitoring wells sampled on July 7, 2015
5. Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map

1 inch = 80 feet

0 12 24 Meters

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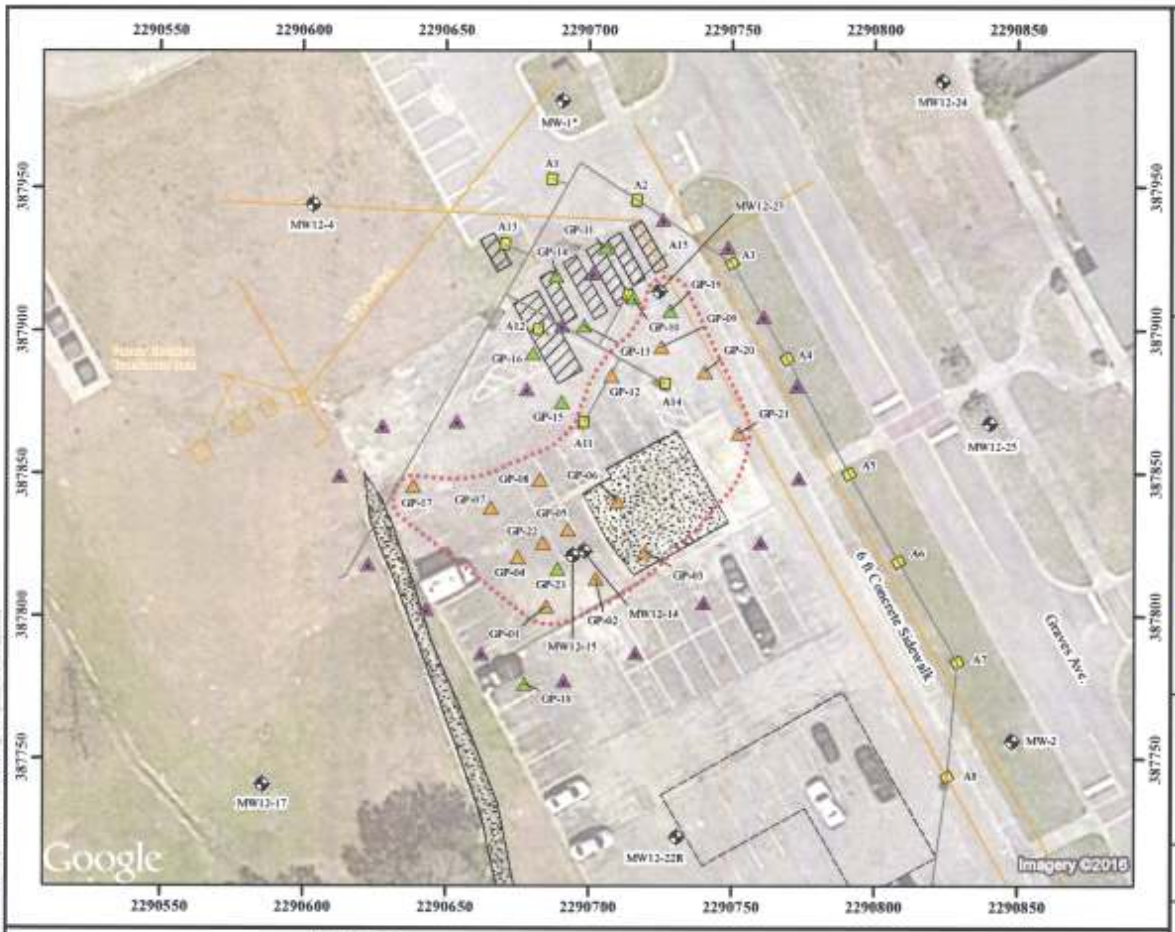
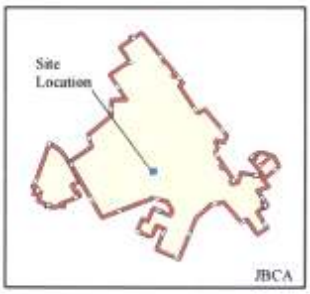
N W E S





Key Features

- Proposed Geoprobe Boring Location
- Geoprobe Boring Location (2012, Sampled)
- Geoprobe Boring Location (2012, Not Sampled)
- Existing Monitoring Well
- Underground Utility Line
- Vault Piping (Abandoned in Place)
- Preliminary Excavation Extent
- Former UST
- Former SVE Well Vault (Decommissioned 2014)
- Demolished Facility
- Former Concrete Drainage Channel
- Former Concrete Pad

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FIGURE 5

AOC I (ST013)
Base Gasoline Station Leak
Proposed Pre-Design Soil Boring Locations and Preliminary Excavation Design

FPM Remediations, Inc.

2016

NOTES:
1. * Labeled MW12-4 in contaminant assessment report (December 1997, Figure 3.1-2)
2. Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map

1 inch = 50 feet

0 7.5 15
Meters

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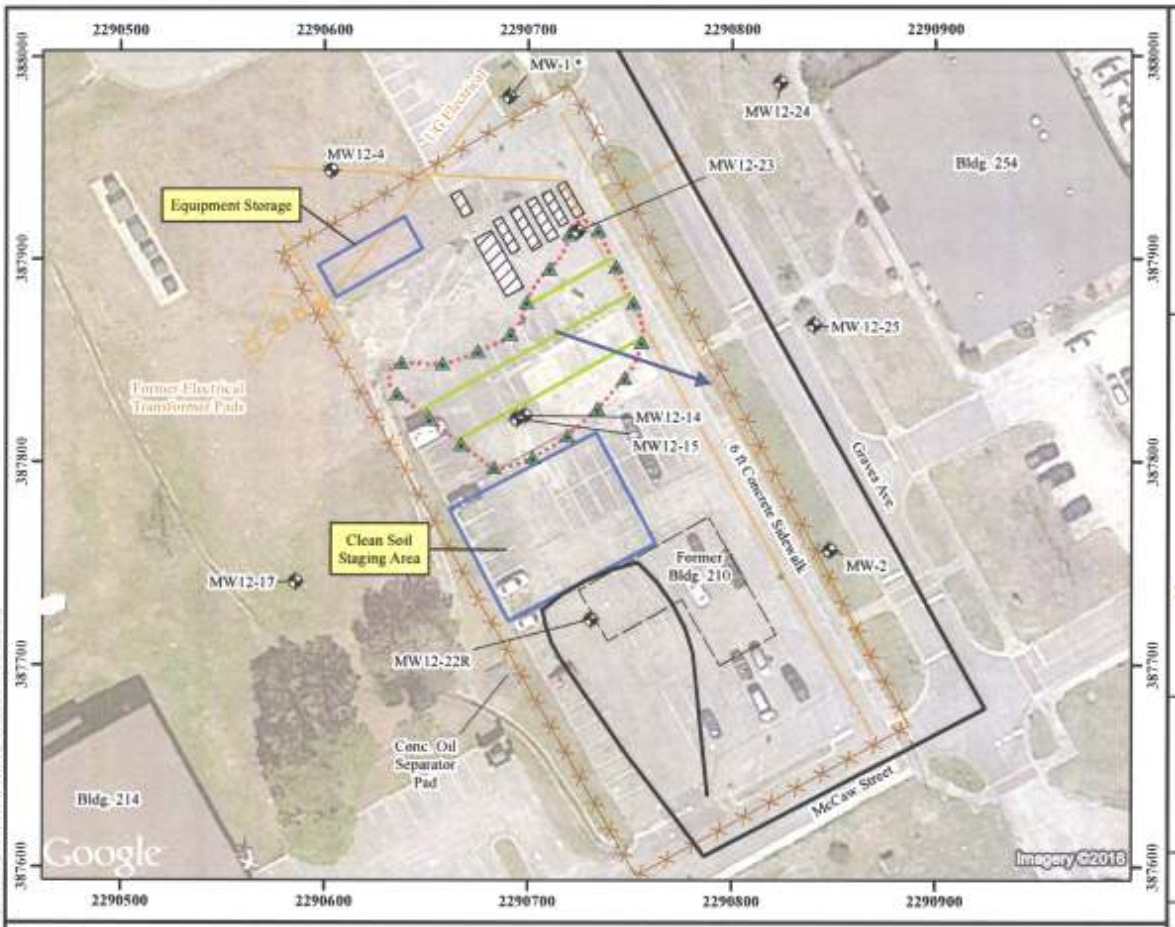

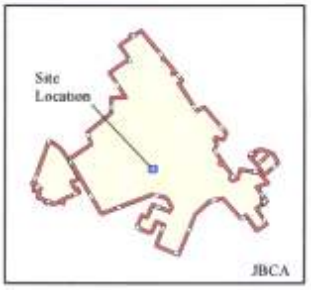

Key Features

- Existing Monitoring Well
- Proposed Confirmatory Soil Sampling Location
- Truck Route
- Groundwater Flow Direction
- Proposed Injection Gallery
- Underground Utility Line
- Proposed Excavation
- Temporary Fencing
- Former UST

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FIGURE 6

AOC I (ST013)
Proposed Confirmatory Soil Sampling Locations and Injection Gallery Design

FPM

2016

NOTES:
Revision Date: 10/5/2016

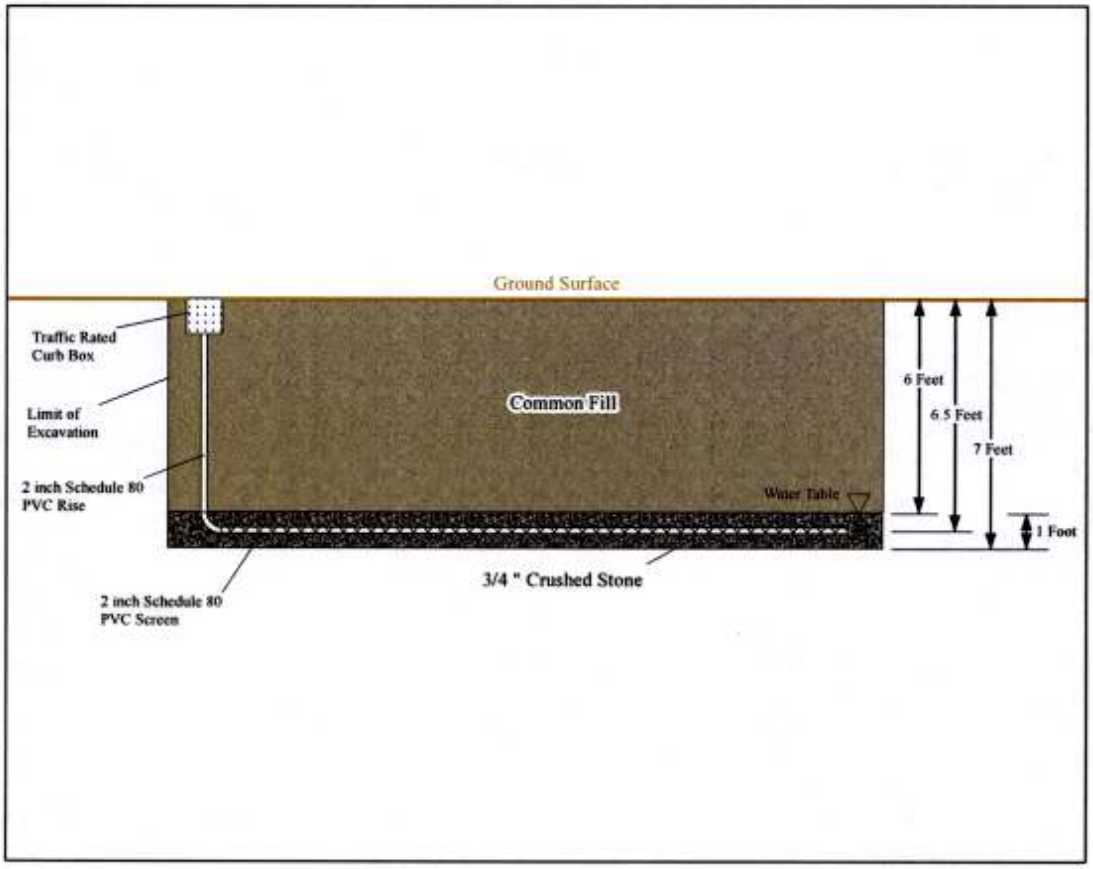
Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
False Easting: 1,968,500.0000
Central Meridian: -82.5000
Standard Parallel 2: 40.0333
Latitude Of Origin: 38.0000
Base Map Date: 2016
Base Map Source: Google
Horizontal Datum: North American 1983
False Northing: 0.0000
Standard Parallel 1: 38.7333
Units: Feet US

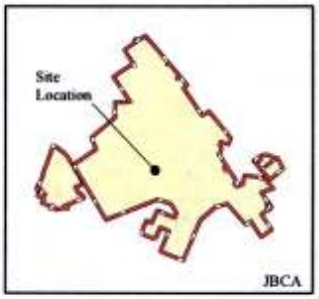
1 inch = 70 feet

0 10.5 21 Meters

0 35 70 Feet

N W E S





Key Features

- 2-inch Schedule 80 PVC Rise
- 2-inch Schedule 80 PVC Screen
- 3/4-inch Crushed Stone
- Common Fill
- Elbow
- Traffic Rated Curb Box

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FIGURE 7

Typical Detail
Injection Gallery

FPM Remediations, Inc.

2016

NOTES:
Revision Date: 10/3/2016

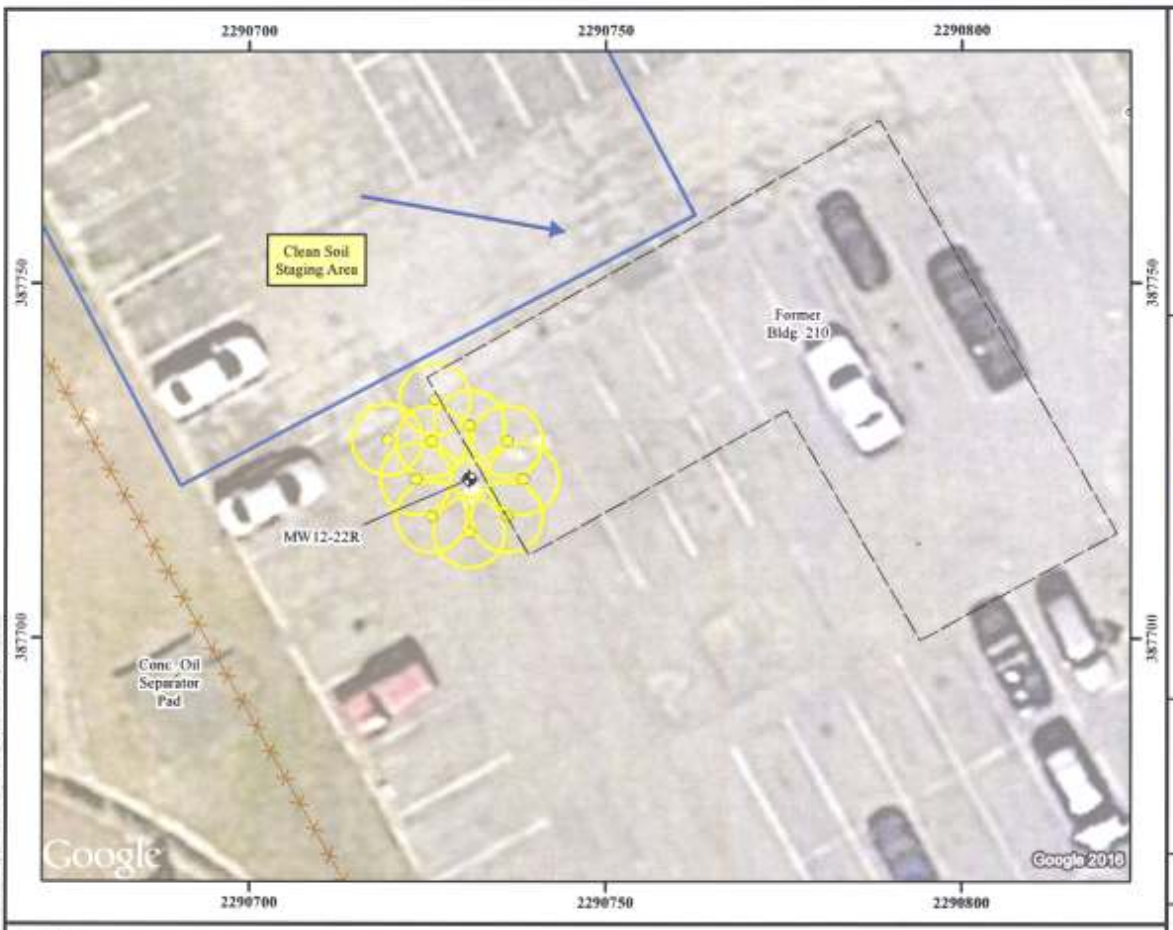
Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map

1 inch = 4 feet

0 0.6 1.2 Meters

0 2 4 Feet

N W E S



Key Features

- Proposed Injection Point
- Existing Monitoring Well
- Groundwater Flow Direction
- Injection 10 ft Diameter
- Construction Features
- Demolished Facility
- Temporary Fencing

NOTES:
Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
False Easting: 1,968,500.0000
Central Meridian: -82.5000
Standard Parallel 2: 40.0333
Latitude Of Origin: 38.8000
Base Map Date: 2016
Base Map Source: Google
Horizontal Datum: North American 1983
False Northing: 0.0000
Standard Parallel 1: 38.7333
Units: Foot US

1 inch = 20 feet
0 2 4 Meters
0 10 20 Feet

N
W E
S

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Joint Base Charleston - Air
North Charleston, SC
AFCEC

FIGURE 8

AOC I (ST013)
Preliminary Groundwater Injection Design

FPM Remediations, Inc.

2016

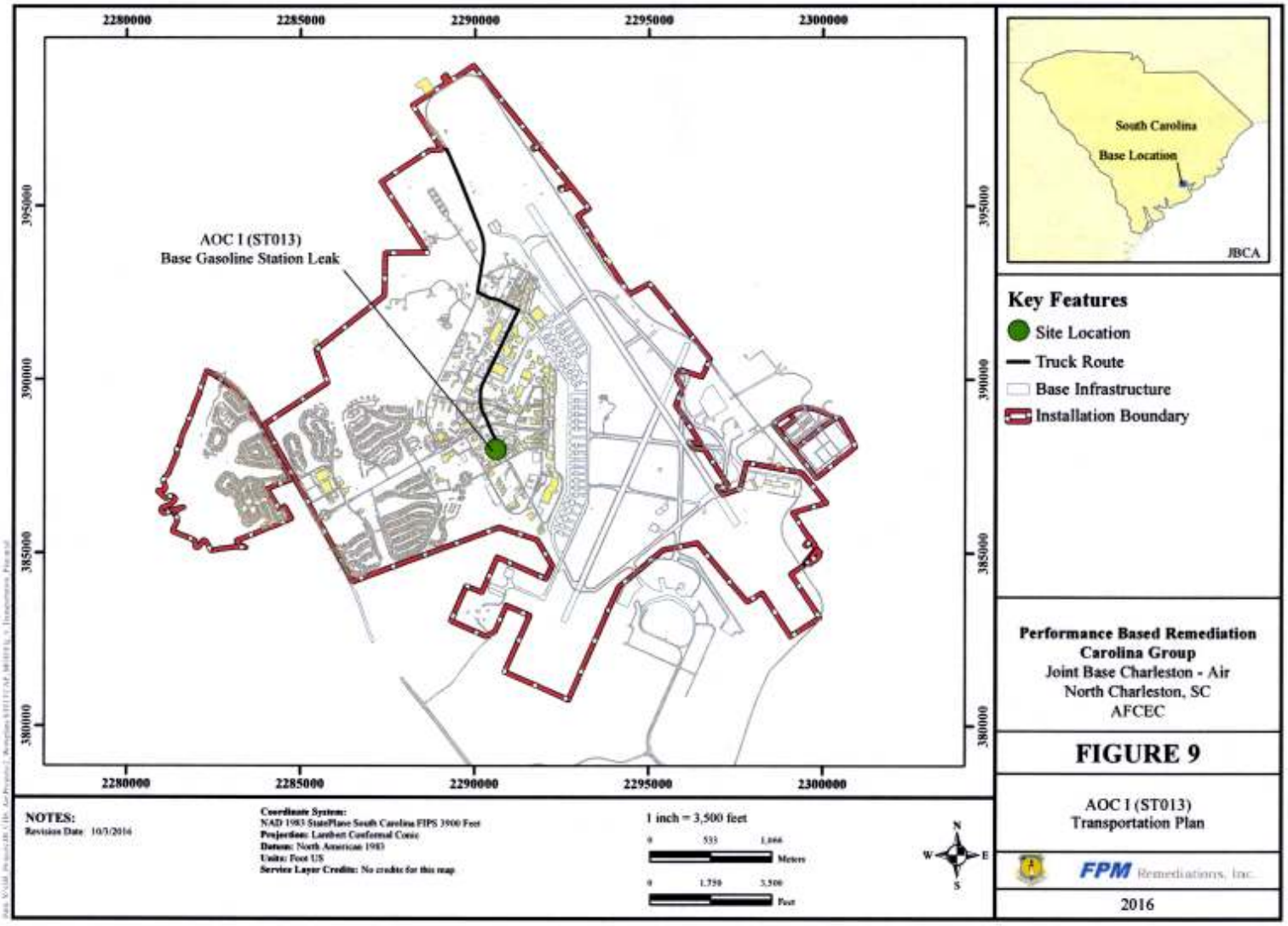
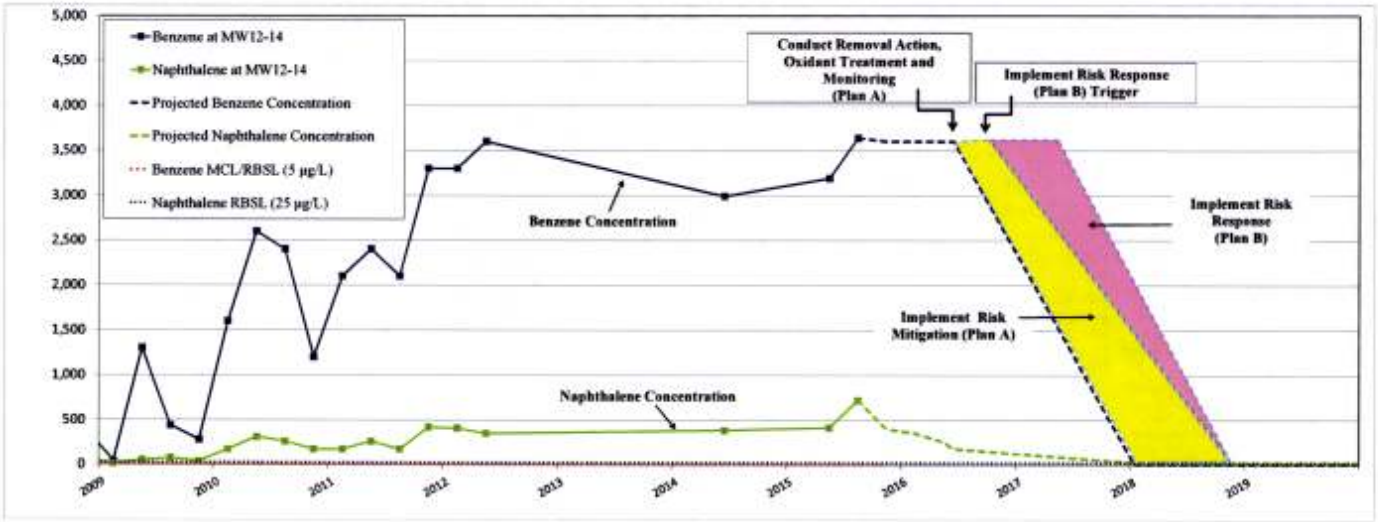

2280000
2285000
2290000
2295000
2300000
395000
390000
385000
380000
AOC I (ST013)
Base Gasoline Station Leak
South Carolina
Base Location
JBCA
Key Features
Site Location
Truck Route
Base Infrastructure
Installation Boundary
NOTES:
Revision Date: 10/3/2016
Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map
1 inch = 3,500 feet
0 533 1,066
Meters
0 1,750 3,500
Feet
N
W
E
S
Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC
FIGURE 9
AOC I (ST013)
Transportation Plan
FPM Remediations, Inc.
2016

Figure 10
Performance Model
Site ST013
JBCA, SC



APPENDIX A
SCDHEC Site Specific Work Plan

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D H E C
PROMOTE PROTECT PROSPER

Site-Specific Work Plan for Approved ACQAP
Underground Storage Tank Management Division

To: Joel Padgett (SCDHEC Project Manager)
From: Gaby Atik (Contractor Project Manager)
Contractor: FPM Remediations **UST Contractor Certification Number:** UCC 0446

Facility Name: AOC I (ST013) Base Gasoline Station Leak **UST Permit #:** GWPD # A-10-AA-13446
Facility Address: North Charleston, South Carolina
Responsible Party: US Air Force **Phone:** 843-963-2701
RP Address: Joint Base Charleston-Air, AFCEC/CZO, Charleston IST, 203 S. Davis Drive, B247, Joint Base Charleston, SC, 29404-4707
Property Owner (if different):
Property Owner Address:
Current Use of Property: Parking Lot

Scope of Work (Please check all that apply)

☐ IGWA	☐ Tier II	☑ Groundwater Sampling	☐ GAC
☐ Tier I	☑ Monitoring Well Installation	☐ Other	

Analyses (Please check all that apply)

Groundwater/Surface Water:

☑ BTEXNMDCA (8260B)	☐ Lead	☐ BOD	☐ Methane
☐ Oxygenates (8260B)	☐ 8 RCRA Metals	☐ Nitrate	☐ Ethanol
☐ EDB (8011)	☐ TPH	☐ Sulfate	☐ Dissolved Iron
☐ PAH (8270D)	☐ pH	☐ Other	

Soil:

☑ BTEXN	☐ 8 RCRA Metals	☐ TPH-DRO (3550B/8015B)	☐ Grain Size
☐ PAH	☐ Oil & Grease (9071)	☐ TPH-GRO (5030B/8015B)	☐ TOC

Air:

☐ BTEXN

Sample Collection (Estimate the number of samples of each matrix that are expected to be collected.)

30 Soil	___ Water Supply Wells	___ Air	9 Field Blank
30 Monitoring Wells	___ Surface Water	6 Duplicate	9 Trip Blank

Field Screening Methodology

Estimate number and total completed depth for each point, and include their proposed locations on the attached map.
# of shallow points proposed: 18 **Estimated Footage:** 5 feet per point
# of deep points proposed: NA **Estimated Footage:** NA feet per point
Field Screening Methodology: PID

Permanent Monitoring Wells

Estimate number and total completed depth for each well, and include their proposed locations on the attached map.
# of shallow wells: 2 **Estimated Footage:** 12 feet per point
# of deep wells: NA **Estimated Footage:** feet per point
# of recovery wells: NA **Estimated Footage:** feet per point
Monitoring Well development method (consistent with SOP):
Comments, if warranted:
Replacement wells are proposed for MW12-14 and MW12-23 which will be removed during the soil excavation.

UST Permit #: GWPD # A-10-AA-13446 Facility Name: AOC I (ST013) Base Gasoline Station Leak

Implementation Schedule (Number of calendar days from approval)
Field Work Start-Up: Within 2 months of Plan Approval Field Work Completion: Within six weeks of commencement
Report Submittal: TBD # of Copies Provided to Property Owners: 2

Aquifer Characterization
Pump Test: ☐ Slug Test: ☐ (Check one and provide explanation below for choice)
None, Remedial Activities

Investigation Derived Waste Disposal
Soil: 1,800 Tons Purge Water: 10,000 Gallons
Drilling Fluids: 30 Gallons Free-Phase Product: 0 Gallons

Additional Details For This Scope of Work
For example, list wells to be sampled, wells to be abandoned/repaired, well pads/bolts/caps to replace, details of AFVR event, etc.
Implementation of the Corrective Action Plan (CAP) consisting of the removal of petroleum contaminated source soils, removal of 3 monitoring wells (MW12-14, MW12-15, and MW12-23), application of an oxidant in the excavation bottom, injection of an oxidant around monitoring well MW 12-22R and conduct 2 performance monitoring and 4 quarterly LTM sampling events over the following year at 5 monitoring wells (MW12-14R, MW12-17, MW12-22R, MW12-23R, and MW12-25).

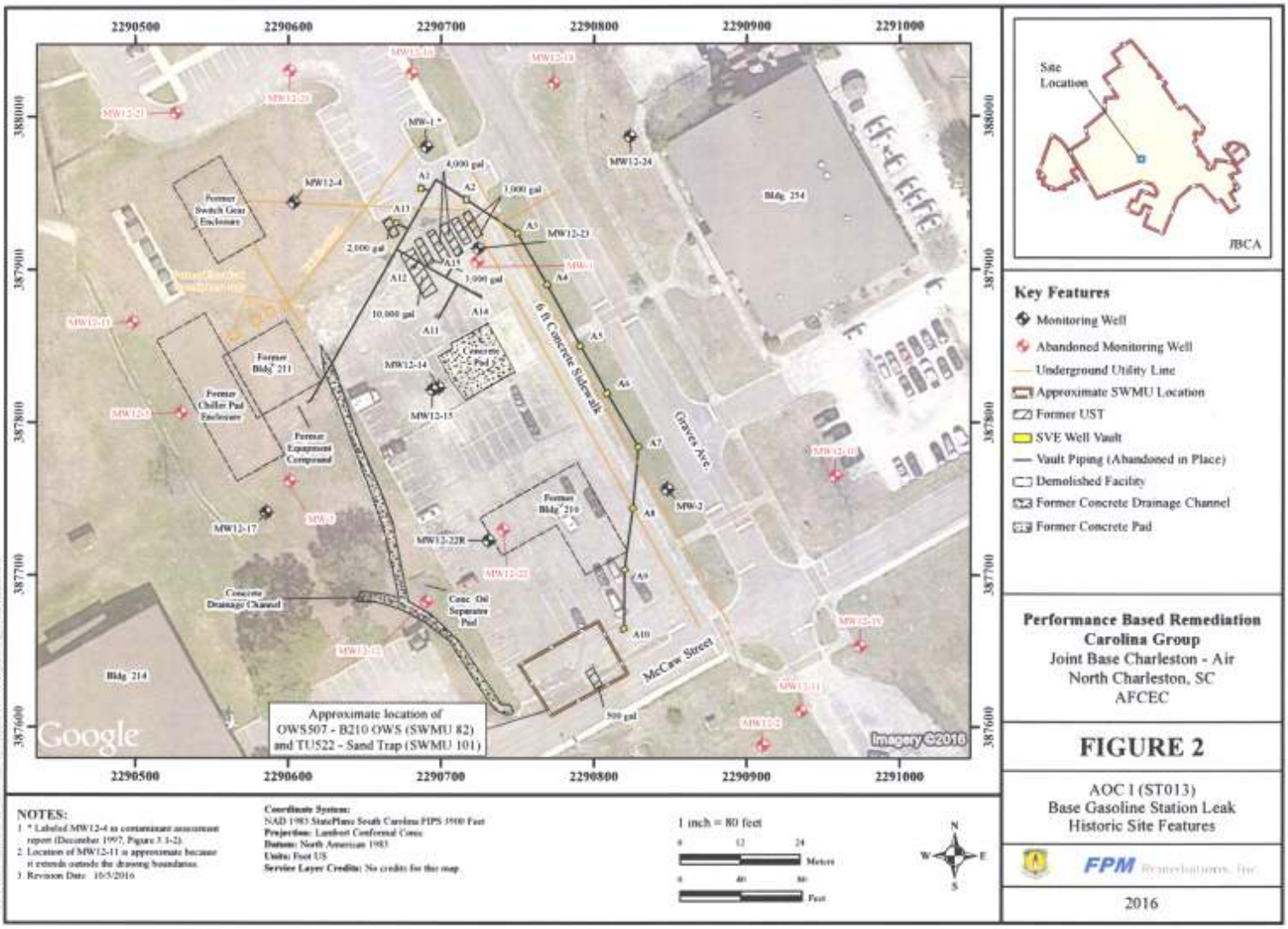
Compliance With Annual Contractor Quality Assurance Plan (ACQAP)
Yes Laboratory as indicated in ACQAP? (Yes/No) If no, indicate laboratory information below.
Name of Laboratory:
SCDHEC Certification Number:
Name of Laboratory Director:

Yes Well Driller as indicated in ACQAO? (Yes/No) If no, indicate driller information below.
Name of Well Driller:
SCLLR Certification Number:

____ Other variations from ACQAP. Please describe below.

Attachments Figures included ~~in attached ACQAP~~

1. Attach a copy of the relevant portion of the USGS topographic map showing the site location - Provided in QAPP.
2. Prepare a site base map. This map must be accurately scaled, but does not need to be surveyed. The map must include the following:
   - North Arrow
   - Location of property lines
   - Location of buildings
   - Previous soil sampling locations
   - Previous monitoring well locations
   - Proposed soil boring locations
   - Proposed monitoring well locations
   - Legend with facility name and address, UST permit number, and bar scale
   - Streets or highways (indicate names and numbers)
   - Location of all present and former ASTs and USTs
   - Location of all potential receptors
3. Assessment Component Cost Agreement, SCDHEC Form D-3664



Key Features

- Monitoring Well
- Abandoned Monitoring Well
- Underground Utility Line
- Approximate SWMU Location
- Former UST
- SVE Well Vault
- Vault Piping (Abandoned in Place)
- Demolished Facility
- Former Concrete Drainage Channel
- Former Concrete Pad

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Joint Base Charleston - Air
North Charleston, SC
AFCEC

FIGURE 2

AOC 1 (ST013)
Base Gasoline Station Leak
Historic Site Features

FPM Remediations, Inc.

2016

NOTES:

1. * Labeled MW12-4 to contaminant assessment report (December 1997, Figure 3-2).
2. Location of MW12-11 is approximate because it extends outside the drawing boundaries.
3. Revision Date: 10/5/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for the map

1 inch = 80 feet

0 12 24 Meters

0 40 80 Feet

N W E S

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APPENDIX B
Oxidant Selection Analysis and Calculations

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REGENESIS

Project Info		
AOC 1 ST013 Joint Base Charleston		
North Charleston SC		
AOC 1 ST013		
Prepared For:		
0.0		
Target Treatment Zone (TTZ) Info	**Unit**	**Value**
Treatment Area	ft^2	1,600
Top Treat Depth	ft	5.0
Bot Treat Depth	ft	15.0
Vertical Treatment Interval	ft	10.0
Treatment Zone Volume	ft^3	16,000
Treatment Zone Volume	cy	593
Soil Type	---	silty sand
Porosity	cm^3/cm^3	0.40
Effective Porosity	cm^3/cm^3	0.20
Treatment Zone Pore Volume	gals	47,875
Treatment Zone Effective Pore Volume	gals	23,938
Fraction Organic Carbon (foc)	g/g	0.003
Soil Density	g/cm^3	1.6
Soil Density	lb/ft^3	100
Soil Weight	lbs	1.6E+06
Hydraulic Conductivity	ft/day	10.0
Hydraulic Conductivity	cm/sec	3.53E-03
Hydraulic Gradient	ft/ft	0.005
GW Velocity	ft/day	0.25
GW Velocity	ft/yr	91
Sources of Oxygen Demand	**Unit**	**Value**
Dissolved Phase Contaminant Mass	lbs	5
Sorbed Phase Contaminant Mass	lbs	20
Reduced Metals (Fe2+ and Mn2+) Mass	lbs	12
BOD mass equivalent	lbs	2
COD mass equivalent	lbs	8
Total Mass Contributing to O_2 Demand	**lbs**	**48**
Stoichiometric Demand	**Unit**	**Value**
Stoichiometric O_2 Demand	lbs	92
Stoichiometric ORC Advanced Demand	**lbs**	**541**
Application Dosing	**Unit**	**Value**
Engineering/Safety Factor	---	**1.0**
ORC Advanced to be Applied	**lbs**	**800**

ORC Advanced® Application Design Summary

AOC 1 ST013	
Application Method	Direct Push
Spacing Within Rows (ft)	10.0
Spacing Between Rows (ft)	10.0
Application Points	16
Areal Extent (square ft)	1,600
Top Application Depth (ft bgs)	5
Bottom Application Depth (ft bgs)	15
ORC Advanced to be Applied (lbs)	800
ORC Advanced per point (lbs)	50
Percent Slurry	30%
Volume Water (gals)	224
Volume ORC Advanced (gals)	36
Total Application Volume (gals)	260
Injection Volume per Point (gals)	16

Field App Instructions

Input special application instructions here as needed.

Field Mixing Ratios
Water per Pt (gals)
14
ORC Advanced per Pt (lbs)
50
Total Volume per Pt (gals)
16

Technical Notes/Discussion

Prepared By: *Name*

Date: *6/21/2016*

Assumptions/Qualifications

In generating this preliminary estimate, Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site.

REGENESIS

Purchasing Information		
AOC 1 ST013 Joint Base Charleston	--	AOC 1 ST013
ORC Advanced Required	lbs	800
ORC Advanced Cost*	$	$5,560
Estimated Tax and Freight %	%	15%
Estimated Tax and Freight Cost	$	$834
Estimated Total Product Cost**	$	$6,394
Estimated RRS Application Cost	$	$14,050
Total Estimated Project Cost	$	$20,444
Estimated RRS Days to Apply	---	2

*Note that the combined tax and freight costs are preliminary estimates only. Please contact your local sales manager or Customer Service at 949-366-8000 to obtain a shipping quote. You will be asked to provide a ship-to address and estimated time of delivery.

Currently Available Packaging Options

Package Type***	# of packages	lbs required
40 lb poly lined bags	20	800

**Total Project cost is only an estimate; actual project cost may change as the final scope and/or RRS proposal are developed.

***Available Package Types are subject to change.

REGENESIS

Project Info		
AOC 1 ST013 Joint Base Charleston North Charleston SC AOC 1 ST013 Prepared For: **0.0**		
Target Treatment Zone (TTZ) Info	**Unit**	**Value**
Treatment Area	ft^2	6,850
Top Treat Depth	ft	5.0
Bot Treat Depth	ft	10.0
Vertical Treatment Interval	ft	5.0
Treatment Zone Volume	ft^3	34,250
Treatment Zone Volume	cy	1,269
Soil Type	---	silty sand
Porosity	cm^3/cm^3	0.40
Effective Porosity	cm^3/cm^3	0.20
Treatment Zone Pore Volume	gals	102,483
Treatment Zone Effective Pore Volume	gals	51,242
Fraction Organic Carbon (foc)	g/g	0.003
Soil Density	g/cm^3	1.6
Soil Density	lb/ft^3	100
Soil Weight	lbs	3.4E+06
Recommended Weight of ORC Advanced/Wt. of Soil	%	0.1%
ORC Advanced Pellets Required	**lbs**	**2,094**
Estimated Degradation Capacity as TPH	*lbs*	*105*

ORC Advanced® Pellets Application Design Summary		
Application Method	--	**Excavation Application**
Excavation Width	ft	68.5
Excavation Length	ft	100.0
Areal Extent (square ft)	sq. ft.	6,850
Top Application Depth (ft bgs)	ft	5
Bottom Application Depth (ft bgs)	ft	10
Estimated Saturated Treatment Thickness	ft	5
ORC Advanced to be Applied (lbs)	**lbs**	**2,094**
ORC Advanced per 1 ft lift	lb/ft	419

Assumptions/Qualifications

In generating this preliminary estimate, Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site.

Prepared By:

Name ***6/21/2016***

REGENESIS

Purchasing Information		
AOC 1 ST013 Joint Base Charleston	**--**	**AOC 1 ST013**
ORC Advanced Required	**lbs**	**2,093.8**
ORC Advanced Cost*	**$**	**$14,552**
Estimated Tax and Freight %	%	15%
Estimated Tax and Freight Cost*	$	$2,183
Estimated Total Product Cost	**$**	**$16,735**

***Note that the combined tax and freight costs are preliminary estimates only. Please contact your local sales manager or Customer Service at 949-366-8000 to obtain a shipping quote. You will be asked to provide a ship-to address and estimated time of delivery.**

OXYGEN RELEASE COMPOUND

ORC Advanced® Pellets Technical Specification

ORC Advanced Pellets are a dust-minimizing, dry application, pelletized form of the widely-used ORC Advanced controlled-release oxygen compound.

They are designed specifically for the treatment of dissolved-phase petroleum hydrocarbons through direct application into excavations, petroleum storage tank pits, trenches and backfill.

Oxygen is released from ORC Advanced for a period of 9 to 12 months *in situ*.

Example of ORC Advanced Pellets

$$CaO(OH)_2 + H_2O \rightarrow \tfrac{1}{2}O_2 + Ca(OH)_2 + H_2O$$

ORC Advanced is a formulation of calcium oxyhydroxide which, upon hydration, releases oxygen and forms simple calcium hydroxide and water.

For a list of treatable contaminants with the use of ORC Advanced, view the Range of Treatable Contaminants Guide.

Chemical Composition

- Calcium Oxyhydroxide
- Calcium Hydroxide
- Monopotassium Phosphate
- Ammonium Phosphate Dibasic

Properties

- Pellet size: 3-10 mm
- Contains micro-nutrients such as nitrogen, phosphorous, and potassium (N,P,K) which can be beneficial to aerobic biodegradation processes

OXYGEN RELEASE COMPOUND

ORC Advanced® Pellets Technical Specification

Storage and Handling Guidelines

Storage

Store in a cool, dry place out of direct sunlight

Store in original tightly closed container

Store in a well-ventilated place

Do not store near combustible materials

Store away from incompatible materials

Provide appropriate exhaust ventilation in places where dust is formed

Handling

Minimize dust generation and accumulation

Keep away from heat

Routine housekeeping should be instituted to ensure that dust does not accumulate on surfaces

Observe good industrial hygiene practices

Take precaution to avoid mixing with combustibles

Keep away from clothing and other combustible materials

Avoid contact with water and moisture

Avoid contact with eyes, skin, and clothing

Avoid prolonged exposure

Wear appropriate personal protective equipment

Applications

- *In situ* or *ex situ* out of the bag
- Direct application into open excavations, petroleum storage tank pits and trenches
- Direct application to contaminated backfill or contaminated soils
- *Ex situ* biopile applications (requires a source of hydration)

Health and Safety

Wash thoroughly after handling. Wear protective gloves, eye protection, and face protection.
Please review the Material Safety Data Sheet for additional storage, usage, and handling requirements here: ORC Advanced SDS.

REGENESIS

www.regenesis.com
1011 Calle Sombra, San Clemente CA 92673
949.366.8000

REGENESIS
Technology-Based Solutions for the Environment

SAFETY DATA SHEET

1. Identification

Product identifier **Oxygen Release Compound Advanced (ORC Advanced®)**

Other means of identification None.

Recommended use Soil and Groundwater Remediation.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Name Regenesis

Address 1011 Calle Sombra
San Clemente, CA 92673

Telephone 949-366-8000

E-mail CustomerService@regenesis.com

Emergency phone number CHEMTREC® at 1-800-424-9300 (International)

2. Hazard(s) identification

Physical hazards	Oxidizing solids	Category 2
Health hazards	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 1

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement May intensify fire; oxidizer. Causes skin irritation Causes serious eye damage.

Precautionary statement

Prevention Keep away from heat. Keep/Store away from clothing/combustible materials. Take any precaution to avoid mixing with combustibles. Wash thoroughly after handling. Wear protective gloves/eye protection/face protection.

Response If on skin: Wash with plenty of water. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse. In case of fire: Use appropriate media to extinguish.

Storage Store away from incompatible materials.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
Calcium hydroxide oxide	682334-66-3	≥85
Calcium hydroxide	1305-62-0	≤15
Dipotassium Phosphate	7758-11-4	<5

Monopotassium Phosphate	7778-77-0	<5

Composition comments All concentrations are in percent by weight unless otherwise indicated.

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes. Rinse skin with water/shower. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.

Eye contact Do not rub eyes. Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.

Ingestion Never give anything by mouth to a victim who is unconscious or is having convulsions. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical attention if symptoms occur.

Most important symptoms/effects, acute and delayed Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes. Skin irritation. May cause redness and pain.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

General information Take off all contaminated clothing immediately. Contact with combustible material may cause fire. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Wash contaminated clothing before reuse.

5. Fire-fighting measures

Suitable extinguishing media Water spray, fog (flooding amounts). Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media None known.

Specific hazards arising from the chemical Greatly increases the burning rate of combustible materials. Containers may explode when heated. During fire, gases hazardous to health may be formed. Combustion products may include: metal oxides.

Special protective equipment and precautions for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions In case of fire and/or explosion do not breathe fumes. Move containers from fire area if you can do so without risk. Use water spray to cool unopened containers.

Specific methods Cool containers exposed to flames with water until well after the fire is out.

General fire hazards May intensify fire; oxidizer. Contact with combustible material may cause fire.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep away from clothing and other combustible materials. Wear appropriate protective equipment and clothing during clean-up. Use a NIOSH/MSHA approved respirator if there is a risk of exposure to dust/fume at levels exceeding the exposure limits. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Collect dust using a vacuum cleaner equipped with HEPA filter. Keep combustibles (wood, paper, oil, etc.) away from spilled material. Ventilate the contaminated area. Stop the flow of material, if this is without risk. Absorb in vermiculite, dry sand or earth and place into containers.

Large Spills. Sweep up or vacuum up spillage and collect in suitable container for disposal. Shovel the material into waste container. Minimize dust generation and accumulation. Avoid the generation of dusts during clean-up. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use. Place all material into loosely covered plastic containers for later disposal. For waste disposal, see section 13 of the SDS. Wear appropriate protective equipment and clothing during clean-up.

Environmental precautions Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling

Minimize dust generation and accumulation. Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces. Keep away from heat. Provide appropriate exhaust ventilation at places where dust is formed. Keep away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Avoid contact with water and moisture. Do not get this material in contact with eyes. Avoid contact with eyes, skin, and clothing. Avoid prolonged exposure. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities

Keep away from heat. Store in a cool, dry place out of direct sunlight. Store in original tightly closed container. Store in a well-ventilated place. Do not store near combustible materials. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

Components	Type	Value	Form
Calcium hydroxide (CAS 1305-62-0)	PEL	5 mg/m3	Respirable fraction.
		15 mg/m3	Total dust.

US. ACGIH Threshold Limit Values

Components	Type	Value
Calcium hydroxide (CAS 1305-62-0)	TWA	5 mg/m3

US. NIOSH: Pocket Guide to Chemical Hazards

Components	Type	Value
Calcium hydroxide (CAS 1305-62-0)	TWA	5 mg/m3

Biological limit values

No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls

Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. If engineering measures are not sufficient to maintain concentrations of dust particulates below the Occupational Exposure Limit (OEL), suitable respiratory protection must be worn. If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection

Use dust-tight, unvented chemical safety goggles when there is potential for eye contact.

Skin protection

Hand protection

Wear appropriate chemical resistant gloves. Frequent change is advisable. Recommended gloves include rubber, neoprene, nitrile or viton.

Other

Wear appropriate chemical resistant clothing.

Respiratory protection

If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Recommended use: Wear respirator with dust filter.

Thermal hazards

Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations

Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state

Solid.

Form

Powder.

Color

White to pale yellow.

Odor	Odorless.
Odor threshold	Not available.
pH	12.5 (3% suspension/water)
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Oxidizer.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	Not available.
Vapor density	Not available.
Relative density	Not available.
Solubility(ies)	
Solubility (water)	Slightly soluble
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	527 °F (275 °C)
Viscosity	Not available.
Other information	
Bulk density	0.5 - 0.9 g/ml
Explosive limit	Non-explosive.

10. Stability and reactivity

Reactivity	Greatly increases the burning rate of combustible materials.
Chemical stability	Decomposes on heating. Product may be unstable at temperatures above: 275°C/527°F.
Possibility of hazardous reactions	Reacts slowly with water.
Conditions to avoid	Heat. Moisture. Avoid temperatures exceeding the decomposition temperature. Contact with incompatible materials.
Incompatible materials	Acids. Bases. Salts of heavy metals. Reducing agents. Combustible material.
Hazardous decomposition products	Oxygen. Hydrogen peroxide (H2O2). Steam. Heat.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Dust may irritate respiratory system. Prolonged inhalation may be harmful.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye damage.
Ingestion	Ingestion may cause irritation and malaise.
Symptoms related to the physical, chemical and toxicological characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Dusts may irritate the respiratory tract, skin and eyes. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity

Components	Species	Test Results
Calcium hydroxide (CAS 1305-62-0)		
Acute		
Oral		
LD50	Rat	7340 mg/kg

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/eye irritation Causes serious eye damage.

Respiratory or skin sensitization

Respiratory sensitization Not a respiratory sensitizer.

Skin sensitization This product is not expected to cause skin sensitization.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Due to the physical form of the product it is not expected to be an aspiration hazard.

Chronic effects Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Components		Species	Test Results
Calcium hydroxide (CAS 1305-62-0)			
Aquatic			
Fish	LC50	Zambezi barbel (Clarias gariepinus)	33.8844 mg/l, 96 hours

Persistence and degradability Decomposes in the presence of water. The product contains inorganic compounds which are not biodegradable.

Bioaccumulative potential The product does not contain any substances expected to be bioaccumulating.

Mobility in soil This substance has very low solubility in water and low mobility in the environment.

Other adverse effects None known.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

DOT

UN number	UN1479
UN proper shipping name	Oxidizing solid, n.o.s. (Calcium hydroxide oxide)
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Label(s)	5.1
Packing group	II
Environmental hazards	
Marine pollutant	No
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	62, IB8, IP2, IP4, T3, TP33
Packaging exceptions	152
Packaging non bulk	212
Packaging bulk	240

IATA

UN number	UN1479
UN proper shipping name	Oxidizing solid, n.o.s. (Calcium hydroxide oxide)
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	No
ERG Code	5L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN1479
UN proper shipping name	OXIDIZING SOLID, N.O.S. (Calcium hydroxide oxide)
Transport hazard class(es)	
Class	5.1
Subsidiary risk	-
Packing group	II
Environmental hazards	
Marine pollutant	No
EmS	F-A, S-Q
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not listed.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - Yes
Pressure Hazard - No
Reactivity Hazard - Yes

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)
Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List
Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)
Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List
Calcium hydroxide (CAS 1305-62-0)

US. New Jersey Worker and Community Right-to-Know Act
Calcium hydroxide (CAS 1305-62-0)
Calcium hydroxide oxide (CAS 682334-66-3)

US. Pennsylvania Worker and Community Right-to-Know Law
Calcium hydroxide (CAS 1305-62-0)

US. Rhode Island RTK
Not regulated.

US. California Proposition 65
California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 02-April-2015

Revision date 30-July-2015

Version # 02

Further information HMIS® is a registered trade and service mark of the American Coatings Association (ACA).

HMIS® ratings Health: 3
Flammability: 0
Physical hazard: 2

NFPA ratings

Disclaimer

Regenesis cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use The information in the sheet was written based on the best knowledge and experience currently available.

APPENDIX C
UIC Application

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Form I UIC	D H E C Underground Injection Control Permit Application Ground-Water Protection Division (Collected under the Authority of Title 48 Chapter I of the 1976 South Carolina Code of Laws)	I. EPA ID NUMBER 3570024460 T/A C U

Read attached instructions before starting.
For OfficialUse Only

Application Approved month day year	Date Received month day year	Permit Well Number

Comments

II. Facility Name and Address	III. Owner/Operator and Address
Facility Name AOC I (ST013) - Base Gasoline Station Leak	Owner/OperatorName Charleston Air Force Base
Street Address Corner of McCaw Street and Graves Avenue	Street Address 100 West Stewart Avenue
City: North Charleston; State: South Carolina; Zip Code: 29404	City: North Charleston; State: South Carolina; Zip Code: 29404

IV. Ownership Status (Select One)

[X] A. Federal [ ] B. State [ ] C. Private [ ] D. Public [ ] E. Other (Explain)

V. SIC Codes

VI. Well Status (Select A, B or C)

[ ] A. Operating | Date Started *(MM/DD/YYYY)* | [ ] B. Modification/Conversion [ ] C. Proposed

VII. Type of Permit Requested - Class and Type of Well (see reverse)

A. Class(es) enter code(s)	B. Type(s) enter code(s)	C. If class is "other" or type is code 'Y', explain	D. Number of Wells per type
V.A.	I		

VIII. Location of Wells or Approximate Center of field or Project

C	A. Latitude				B. Longitude			
I		Deg 32°	Min 53'	Sec 45"	Deg 80°	Min 3'	Sec 14"	

IX. Attachments

Complete the following questions on a separate sheet(s) and number accordingly; see instructions for Classes 11, 111, and V, complete and submit on a separate sheet(s) attachments A-U as appropriate. Attach maps where required. List attachments by letter which are applicable and include with your application.

X. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment.

A. Name (Type or Print)	Title	B. Phone No.
C. Signature		D. Date Signed (MM/DD/YYYY)

Well Class and Type Codes

Class I			Industrial, municipal, and other injection wells for the subsurface disposal of fluids. (Prohibited)
Class II			Oil and gas production and storage related injection wells.
	Type	"D"	Produced fluid disposal well
		"R"	Enhanced recovery well
		"R"	Hydrocarbon storage well (excluding natural gas)
		"X"	Other Class II wells
Class III			Special process injection wells.
	Type	"G"	Solution mining well
		"S"	Sulfur mining well by frasch process
		"U"	Uranium mining well (excluding solution mining of conventional mines)
		"X"	Other Class III wells
Class IV			Hazardous or radioactive waste disposal injection wells. (Prohibited)
Class V.A			Injection wells not included in Class I, II, III, IV or V.B
	Type	"A"	Storm runoff drainage wells
		"B"	Aquifer recharge wells
		"C"	Salt-water intrusion barrier wells
		"D"	Subsidence control wells
		"E"	Backfill wells associated with subsurface mining
		"F"	Geothermal energy recovery wells
		"G"	Experimental technology well
		"H"	Natural gas storage wells
		"I"	Corrective action wells
Class V.B			Non-contact return flow system wells
	Type	"A"	Heat pump return flow wells
	Type	"B"	Cooling water return flow wells

Instructions for Attachments to Form 1
Underground Injection Control
for Corrective Action Wells
(effective 01/91)

The following ATTACHMENTS should be submitted with an underground injection control (UIC) permit application for Class V.A. corrective action wells associated with aquifer remediation that are to be used to inject fluid whose chemical constituents are below all drinking water standards, as established under R.61-58.5.

Attachment A: Activity for Review

Submit a brief description of the activities to be conducted that require a UIC permit.

Attachment B: Well Construction Details

Submit schematic or other appropriate drawings of the surface and subsurface construction details of the recovery and injection wells.

Attachment C: Operating Data

Submit the following proposed operating data for each injection well:

1) Average and maximum daily rate and volume of fluid to be injected. In addition, indicate the average and maximum daily rate and volume of fluid to be withdrawn from each recovery well. Verification of the aquifer's hydraulic ability to produce and accept the quantities proposed should be presented.

2) Average and maximum injection pressure.

3) Pumping schedule (i.e. continuous, alternating cycles, etc.).

4) Proposed ranges in the concentration of all contaminant constituents within the injection fluid. Include comprehensive ground-water quality data from a "worst case" well sample.

5) Length of time the project is expected to require injection to complete remediation (to ensure the effective dates of the permit will allow sufficient time to complete the project).

Attachment D: Monitoring Program

Discuss the planned monitoring program in detail:

1) Include a discussion of monitoring devices, sampling frequency (sufficient to verify treatment system efficiency), sampling protocol, sampling location, parameters to be analyzed, and proposed method(s) of analysis.

2) This plan should indicate how, through monitoring, the proposed contaminant levels in the injectate will be verified.

3) This plan should also clearly illustrate exactly how hydraulic control of the contaminant plume (and injectate, where relevant) will be verified through monitoring (i.e., piezometers, quality analyses, etc.).

Attachment E: Existing or Pending State/Federal Permits

List the program and permit number of any existing State or Federal permits for the facility (i.e., NPDES, RCRA, UST, etc.).

Attachment F: Description of Business

Give a brief description of the nature of the business of the facility and any immediately adjacent facilities.

Attachment G: Area of Review

1) The area of review should be a fixed radius of 1/4 mile from the injection well, the outermost injection wells (if a wellfield).

2) If a fixed radius is not selected, the methods and the calculations used to determine the size of the area of review should be submitted.

Attachment H: Maps of Wells and Area of Review

1) Submit a topographic map of the area, extending one mile beyond the project property boundaries. This map should show all hazardous waste treatment, storage, or disposal facilities, and all intake and discharge structures associated with the project facility. Any known areas of soil and/or ground-water contamination within a one mile radius should be indicated. Also indicate all surface bodies of water, springs, mines (surface and subsurface), quarries, and other pertinent surface features such as residences, roads, and geologic faults (known or suspected).

2) A scaled map(s) should be included which shows the name and/or number and the location of ALL production, injection, monitoring, abandoned and dry wells within the area of review. This should be accomplished by file and field surveys. Information regarding the construction (i.e., total depth, diameter, casing/screened intervals, grouting, etc.) and the current status (i.e., actively used, temporarily abandoned, permanently abandoned) of ALL wells within the area of review should be submitted. If any wells have been abandoned, details on the method the wells were abandoned (i.e., cemented/grouted, filled with sand, etc.) should be included.

3) A potentiometric map of the project site should be submitted which accurately locates all monitoring wells and proposed recovery and injection wells and outlines the horizontal extent of both the free-phase contaminant (where applicable) and dissolved contaminant plumes. Include all water level and product thickness data. The date and time that water levels and product thicknesses were measured should be indicated.

Attachment I: Cross Sections/Diagrams

1) Geologic cross sections indicating the lithology and stratigraphy of the site and the horizontal and vertical extent of the contaminant plume, should be submitted. At least two stratigraphic cross sections, one parallel and one perpendicular to the horizontal ground-water flow direction, should be submitted. In areas where the site stratigraphy is complex, additional cross sections should be submitted to clearly illustrate the local conditions.

2) A schematic diagram, in the form of a cross section, showing the proposed remediation system with the components of flow (above and below ground) and all associated appurtenances (i.e., stripping tower, piping, wells, etc.).

Attachment J: Name and Depth of Underground Sources of Drinking Water (USDW's)

Identify and describe all aquifers which may be affected by the injection.

Attachment K: Hydraulic Control

1) Sufficient supporting data (i.e. time/drawdown data, Theis curves and methods, calculations, etc.), used to determine aquifer characteristics to verify complete hydraulic control over the contaminant plume (and injectate, if proposed injectate quality does not conform to classified ground-water standards) during injection should be submitted. At a minimum, values should be given for transmissivity, hydraulic conductivity, effective porosity and specific yield.

2) Demonstrate the presence and magnitude of, or the absence of, any vertical hydraulic gradient at the site. If a vertical hydraulic gradient exists, show how its direction and magnitude are incorporated in the calculations demonstrating hydraulic control.

3) Ground-water flow computer models (especially 2-D map view with potentiometric and flow lines) may be utilized and submitted. All calculations should be in English units. All model-derived data and maps should be properly labeled and keyed so as to be clearly understood.

Subsequent Action

After receipt of a complete Underground Injection Control Permit Application, the Department will make a determination to deny or issue a Permit to Construct the injection well(s). After the well(s) is/are constructed, the Department should be notified in writing of the well(s) completion and sent a copy of the completed well record form(s) signed by a South Carolina certified well driller which illustrates the "as built" well construction. If the system is in compliance with the approved application, the Department may then issue an Approval to Operate. This Approval to Operate is the final permission necessary prior to injection.

Attachments to Form I – Underground Injection Control Permit Application for Oxidant Injection at Area of Concern I (ST013) – Base Gasoline Station Leak Joint Base Charleston-Air North Charleston, South Carolina

Attachment A: Activity for Review

This Underground Injection Control (UIC) Permit Application is being submitted for the injection of oxidant solution at the Area of Concern (AOC) I (ST013) site at Joint Base Charleston-Air (JBCA) to remediate a hot spot area around monitoring well MW12-22R. The field effort will include injecting an oxidant through Geoprobe drill rods at 10 injection locations at multiple depths around monitoring well MW12-22R to effectively distribute the oxidant solution. An estimated total of 800 pounds of ORC A will be injected in approximately 140 gallons of slurry. Each of the 10 locations would receive approximately 16 gallons injected between approximately 5 feet and 15 feet below ground surface (bgs). The injection of ORC A solution will remediate groundwater contaminants of concern benzene and naphthalene.

Attachment B: Well Construction Details

Since Geoprobe direct-push drill rods will be utilized for solution injection, no permanent or temporary injection wells will be installed. Therefore, an injection well construction diagram is not provided. The proposed injection well locations are provided as **Figure 1.**

Attachment C: Operating Data

The fluid to be injected: ORC A

Number of injection wells: 10 Geoprobe injection wells

The following operating data are proposed for each injection well:

1) Average and maximum daily rate and volume of oxidant solution to be injected: Approximately 16 gallons per well or approximately 1.6 gallons per foot over the 10 foot injection interval will be pressure injected.

2) Average and maximum daily rate and volume of air/groundwater to be withdrawn from each recovery well: No recovery wells are planned for this project.

3) Average and maximum injection pressure: Due to the shallow depth of the water table, injections will be performed by gravity draining (low pressure), to prevent daylighting.

4) Pumping schedule: The oxidant solution will be continuously pumped from the bottom to the top at each location until the desired amount is injected. Injection will be performed in one discrete event spanning two days.

5) Proposed ranges in the concentration of all contaminant constituents within the injection fluid: No site contaminants (benzene and naphthalene) will be in the injected fluid.

6) Length of time the project is expected to require injection to complete remediation: Until the benzene concentration is reduced to below the United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL), and the naphthalene concentration is below the South Carolina Department of Health and Environmental Control (SCDHEC) Risk-Based Screening Level (RBSL). The MCL for benzene is 5 micrograms per liter (µg/L) and the RBSL for naphthalene is 25 µg/L. FPM Remediations, Inc. (FPM) will conduct one injection event during the first year (2016) and based on the results of the four quarterly post-injection groundwater performance monitoring sampling events, a second or third injection event may be necessary in 2017 and 2018, respectively.

Attachment D: Monitoring Program

During injections, the following observations will be recorded for each injection location: quantities of amendment and water injected, injection data (e.g., injection flow rate, injection pressure, and total quantity injected), surfacing of amendment, and water levels at adjacent wells. In addition, the injection system will be continuously monitored for leaks from fittings and hoses. In the event of a large leak, injection equipment will be shut down until appropriate repairs are made.

Performance monitoring of groundwater will be conducted to assess the efficacy of the injection event. The locations of monitoring wells are shown on **Figure 1** and described below.

The 4th Quarter 2015 (October) groundwater sampling event will serve as the baseline (pre-injection) monitoring event. After the first oxidant injection, groundwater performance monitoring samples will be collected quarterly. The goal of the monitoring program is to monitor changes in the groundwater quality, and assess the performance of the chemical injection to evaluate remediation progress.

Groundwater samples will be collected from existing monitoring well MW12-22R. Groundwater samples will be collected using the low-flow method and peristaltic pumps, and analyzed for benzene and naphthalene by USEPA Method 8260B. Field geochemistry parameters (dissolved oxygen, oxidation-reduction potential, pH, temperature, turbidity, and specific conductivity) will be measured using a flow-through cell to demonstrate the effectiveness of the oxidant application.

Groundwater sampling and analysis will be performed in accordance with the procedures and methods described for current, ongoing long-term monitoring (LTM) in the existing Site Specific Work Plan (SSWP) (FPM, 2016).

Attachment E: Existing or Pending State/Federal Permits

An UIC permit to be issued by SCDHEC prior to injection activities.

JBCA has an existing Resource Conservation and Recovery Act (RCRA) Part B Permit SC3 570 024 460, dated October 4, 2010, executed with SCDHEC, a delegated authority by the USEPA for RCRA Corrective Actions. The current LTM program at the site was optimized and the final SSWP (FPM, 2016), was approved by SCDHEC in a letter dated 2 August 2016. Nine monitoring wells (MW-1, MW-2, MW12-14, MW12-15, MW12-17, MW12-22R, MW12-23, MW12-24, and MW12-25) will be sampled annually for benzene and naphthalene.

RCRA corrective actions at JBCA are also conducted pursuant to a Federal Facilities Agreement (FFA) executed between USEPA Region IV, the State of South Carolina, and the U.S. Air Force (USAF), dated November 16, 1992.

Attachment F: Description of Business

JBCA is an active U.S. Department of Defense facility. It is adjacent to the City of North Charleston and is 3,731 acres in area, with an approximate population of 5,500. The population changes periodically as military operations vary from year to year and/or from mission to mission. The facility is highly developed, with most land used for military operations and housing, including airfield runways and taxiways that are shared with the Charleston International Airport. JBCA is surrounded by industrial, commercial, and residential properties that are part of the City of North Charleston, South Carolina.

Attachment G: Area of Review

Using the permanent monitoring wells at the AOC I site, the area of review is less than ¼ mile radius from the proposed injection locations, as shown on **Figure 2**. From the injection location to be monitored, monitoring well MW-2 is the farthest monitoring well downgradient currently in the monitoring program.

Attachment H: Maps of Wells and Area of Review

The following figures are attached to this UIC Permit Application:

1) A topographic map is provided as **Figure 3**, extending one mile beyond the project property boundaries. There are no hazardous waste treatment, storage, or disposal

facilities associated with this site. Locations of other RCRA Corrective Action Solid Waste Management Units (SWMUs) and AOCs are shown.

2) The site monitoring wells are provided as **Figure 1**. Well completion details can be found in the previously submitted 3rd Quarter LTM Report (FPM, 2015).

3) A groundwater elevation contour map (potentiometric map) of the site is provided as **Figure 4**. No free product has been observed at this site. The proposed injection well locations are provided as **Figure 1**. The extent of benzene and naphthalene contamination in groundwater is provided as **Figure 5**.

Attachment I: Cross Sections/Diagrams

A geologic cross-sections are provided as **Figure 6**, which was extrapolated from the Contaminant Assessment Report for AOC I, Former Service Station Tank Link (Radian International [Radian], 1997). Since this is a copy from the document referenced above, the quality is not very good; however, the geologic cross-sections show lithology and stratigraphy of the site. The screen section of monitoring well MW12-22R are set in poorly graded fine sand/silty sand/sandy silt. Contamination has been detected in groundwater samples collected from the shallow portion of the surficial aquifer (Ladson Formation).

Attachment J: Name and Depth of Underground Sources of Drinking Water (USDW's)

There are no USDWs that will be affected by the injections. Products will be injected into the shallow water table found in the Ladson Formation.

Attachment K: Hydraulic Control

The surface at the site consists of varying thicknesses of fill material from 1 to 3 feet. The fill material consists of sand, silt, clay, or gravel (Radian, 1996). The fill overlies the Pleistocene Ladson Formation, which consists of silty sand, frequently interbedded with silty clay stringers. A clay layer of an approximate thickness of 17 to 20 feet was encountered at depths ranging from 17 to 25 feet below ground surface (bgs) at the site. This clay is reportedly interbedded with silt and sand lenses throughout the entire thickness. The clay represents the base of the Ladson Formation, and overlies carbonate deposits of the Oligocene Cooper Marl (Radian, 1996). According to the Contaminant Assessment Report the top of the Cooper Marl was only encountered in one boring at a depth of approximately 34 feet (Halliburton NUS Corporation [Halliburton], 1994).

Hydrogeological conditions at the site are characterized by a very shallow unconfined aquifer. The groundwater table at the site is usually encountered at depths of approximately 5 to 6 feet bgs. The host formation for this aquifer is the Ladson Formation previously described. Recharge primarily occurs through infiltration from rainfall. Groundwater flow direction across

most of the eastern portion of the site was determined to be towards the east, however, a groundwater divide was reported in the central portion of the site and groundwater flow in the north-central portion is generally to the north (Radian, 1996). The hydraulic gradient was previously calculated to be equal to 0.005 feet/foot (ft/ft) along the eastern portion of the site (Halliburton, 1994). West of the groundwater divide, the gradient appears to be steeper and is approximately equal to 0.017 ft/ft. A 52-hour hydraulic pumping test was conducted to evaluate the hydraulic properties of the shallow aquifer. Based on the results, a hydraulic conductivity of 12.2 ft/day was calculated for the site (Radian, 1996). The hydraulic conductivity and gradient information along with an assumed effective porosity of 30 percent (%), was used to estimate groundwater flow velocities ranging from 74.1 ft/year to the east of the groundwater divide and 252 ft/year to the west of the divide (Radian, 1996). The Cooper Marl (with a thickness of over 200 feet) is believed to be an effective aquitard separating the shallow unconfined aquifer from significantly deeper confined systems.

LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
bgs	below ground surface
COC	Contaminant of Concern
FFA	Federal Facilities Agreement
FPM	FPM Remediations, Inc.
ft/day	feet per day
ft/ft	feet per foot
ft/yr	feet per year
JBCA	Joint Base Charleston-Air
LTM	Long-Term Monitoring
µg/L	micrograms per liter
MCL	Maximum Contaminant Level
%	percent
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
SCDHEC	South Carolina Department of Health and Environmental Control
SSWP	Site Specific Work Plan
SWMU	Solid Waste Management Unit
UIC	Underground Injection Control
USAF	United States Air Force
USDW	Underground Sources of Drinking Water
USEPA	United States Environmental Protection Agency

LIST OF FIGURES

REFERENCES

Earth Tech, Inc., 2009, Underground Injection Control Permit Application for OBC+ Injections Charleston Air Force Base, SC, Site AOC I (ST013), January 23.

FPM Remediations, Inc. (FPM), 2015, Draft Final Third Quarter 2015 Groundwater Monitoring Report AOC I (ST013) – Base Gasoline Station Leak GWPD Site #A-10-AA-16344, Joint Base Charleston-Air, December.

FPM, 2016, Final Annual Contractor Quality Assurance Plan (SSWP), Performance-Based Remediation at JB CHS-Air, July.

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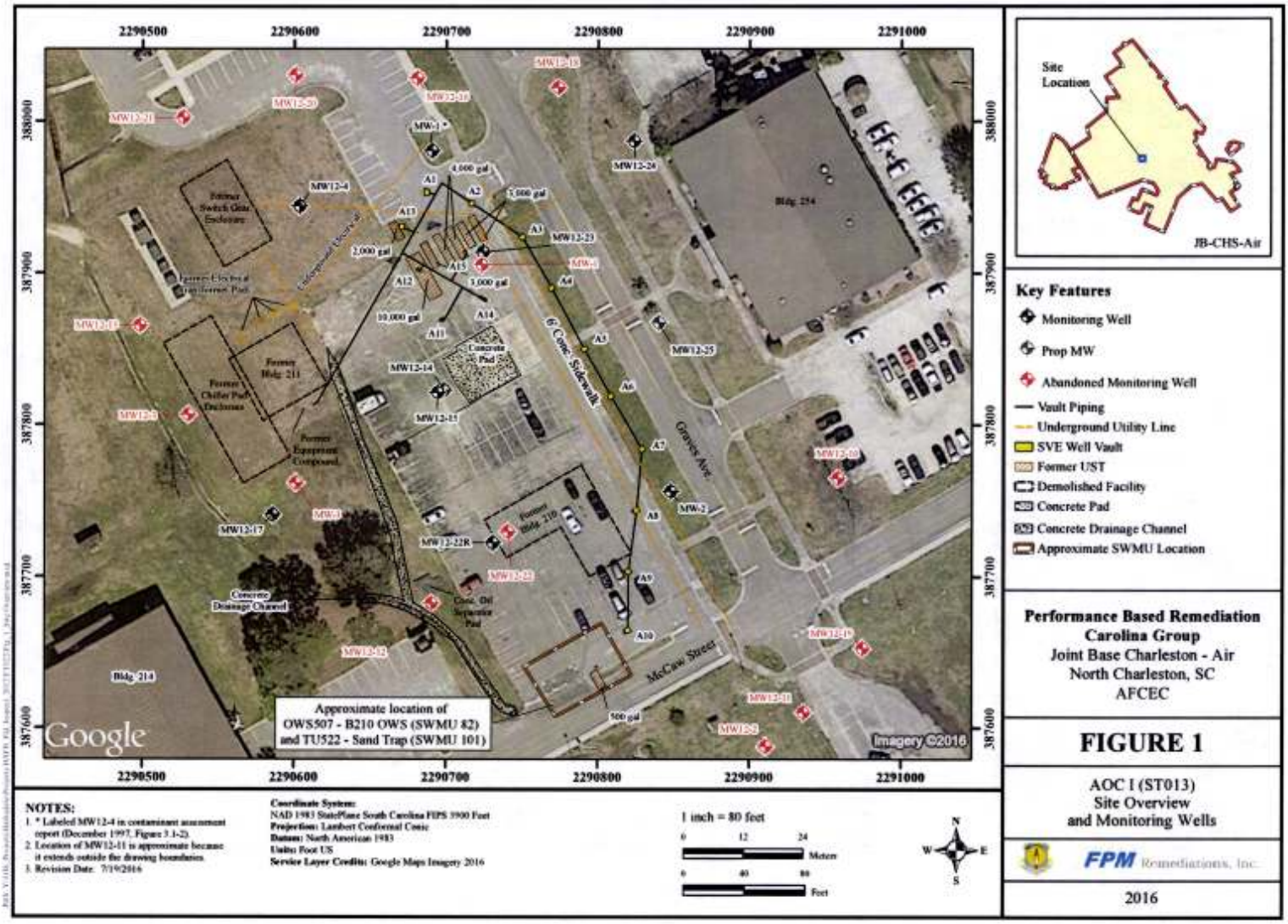
Radian, 1997, Contaminant Assessment Report, AOC I, Former Service Station, December.



Key Features

- Monitoring Well
- Prop MW
- Abandoned Monitoring Well
- Vault Piping
- Underground Utility Line
- SVE Well Vault
- Former UST
- Demolished Facility
- Concrete Pad
- Concrete Drainage Channel
- Approximate SWMU Location

NOTES:

1. * Labeled MW12-4 in containment assessment report (December 1997, Figure 3.1-2).
2. Location of MW12-11 is approximate because it extends outside the drawing boundaries.
3. Revision Date: 7/19/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Google Maps Imagery 2016

1 inch = 80 feet

0 12 24 Meters

0 40 80 Feet

N W E S

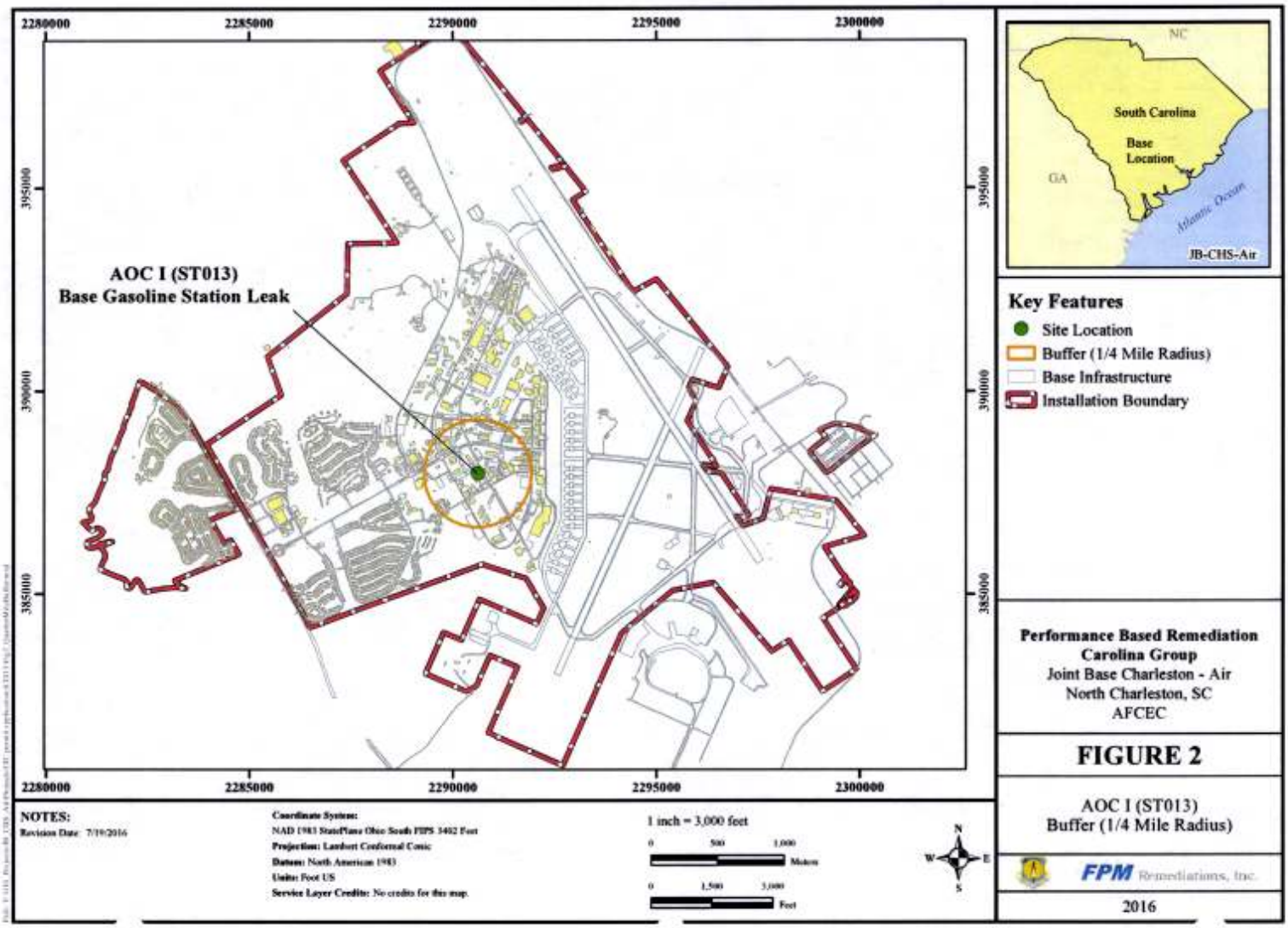
Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC

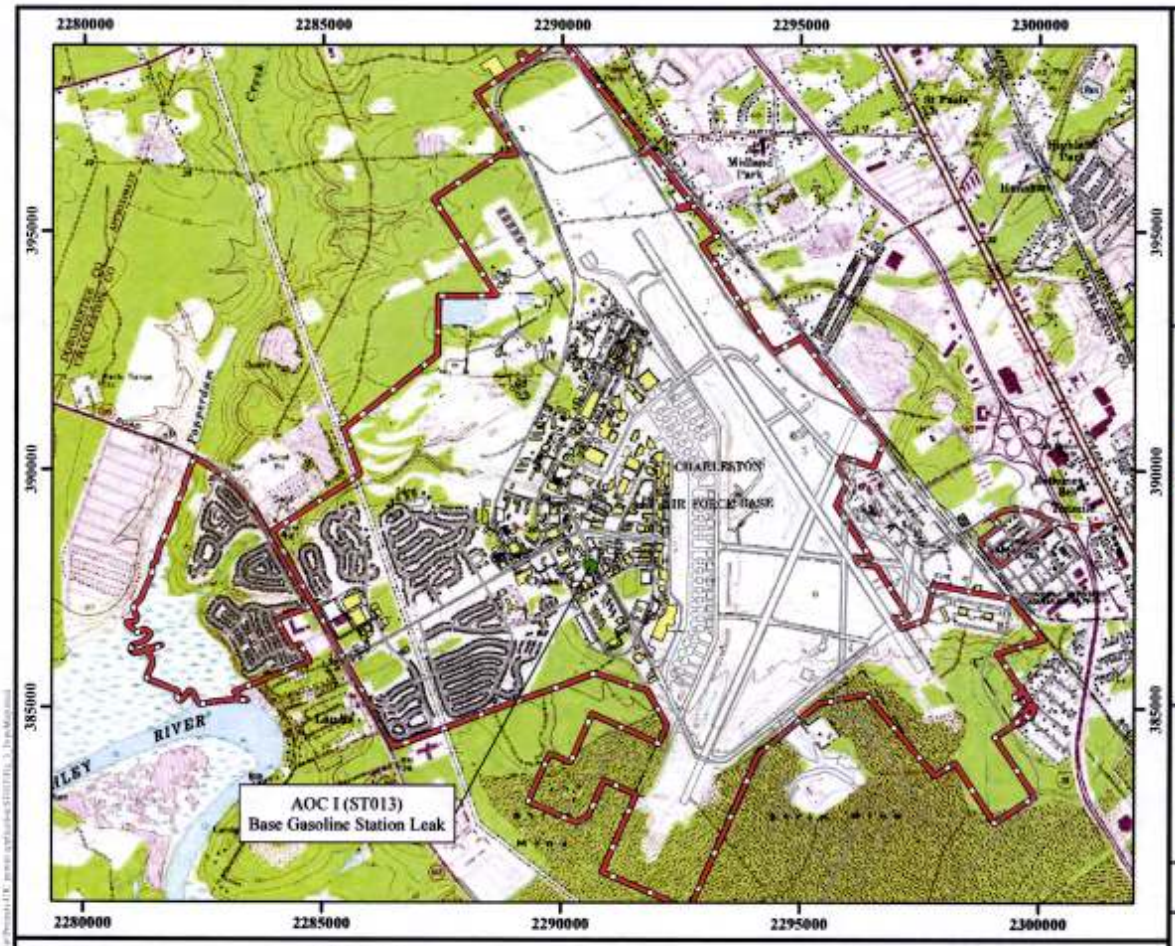
FIGURE 1

AOC I (ST013)
Site Overview
and Monitoring Wells

FPM Remediations, Inc.

2016


2280000
2285000
2290000
2295000
2300000
395000
390000
385000
AOC I (ST013)
Base Gasoline Station Leak
NC
South Carolina
Base
Location
GA
Atlantic Ocean
JB-CHS-Air
Key Features
Site Location
Buffer (1/4 Mile Radius)
Base Infrastructure
Installation Boundary
NOTES:
Revision Date: 7/19/2016
Coordinate System:
NAD 1983 StatePlane Ohio South FIPS 3402 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: No credits for this map.
1 inch = 3,000 feet
0
500
1,000
Meters
0
1,500
3,000
Feet
N
W
E
S
Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC
FIGURE 2
AOC I (ST013)
Buffer (1/4 Mile Radius)
FPM Remediations, Inc.
2016



Key Features

- AOC I (ST013) Location
- Base Infrastructure
- Installation Boundary

Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC

FIGURE 3

AOC I (ST013)
Base Gasoline Station Leak
Topographic Map

FPM Remediations, Inc.

2016

NOTES:
Revision Date: 7/19/2016

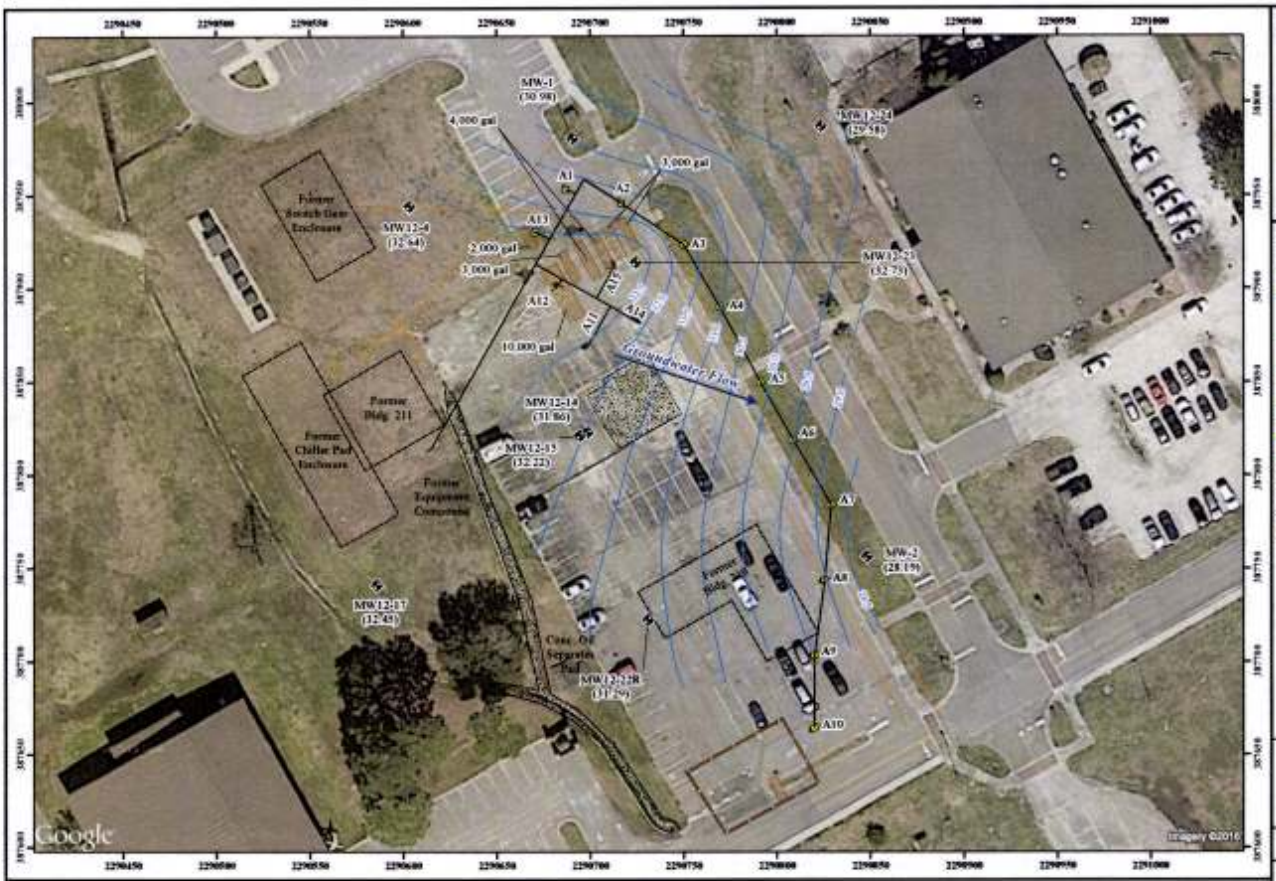
Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Ladson Quad, South Carolina
USGS Digital Raster Graphics (DRG).
Publication Date: July 24, 1997

1 inch = 3,000 feet

0 500 1,000 Meters

0 0.25 0.5 Miles

N W E S



Legend

- Existing Monitoring Well
- Inferred Groundwater Elevation Contour (ft amsl)
- Groundwater Elevation Contour (ft amsl)
- Groundwater Flow Direction
- Underground Utility Line
- Former Vault Piping
- Former UST
- Former SVE Well Vault
- Demolished Facility
- Concrete Pad
- Concrete Drainage Channel
- Approximate SWMU Location

NOTES:
1. Groundwater depths were measured on July 7, 2015.
2. Revision Date: 7/15/2016

Coordinate System: NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Google Maps Imagery 2016

1 inch = 59 feet
0 7.5 15 Meters
0 25 50 Feet

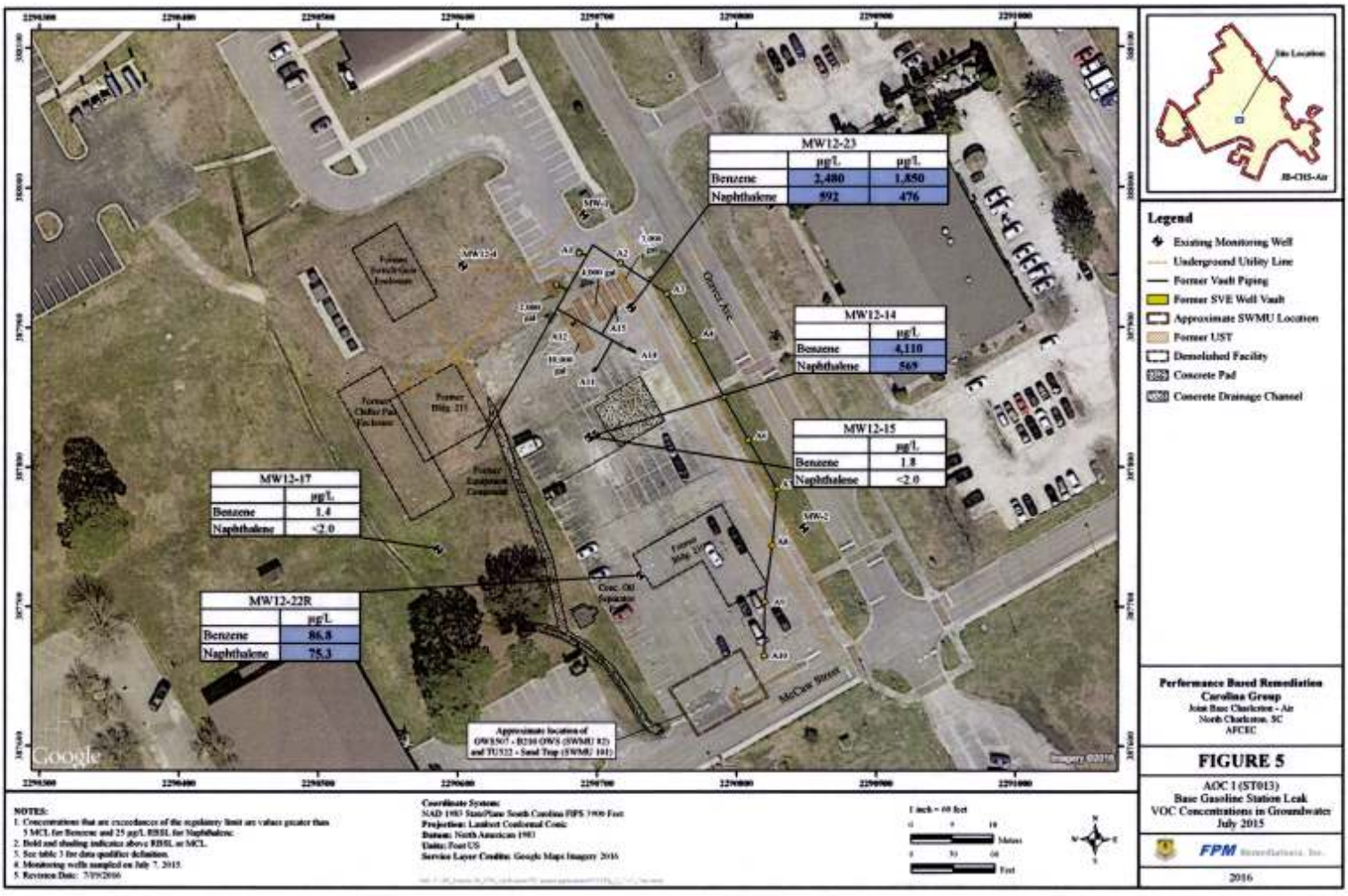
Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
APCBC

FIGURE 4

AOC 1 (ST013)
Base Gasoline Station Leak
Water Table Elevation Contours
July 2015

FPM

2016



NOTES:
1. Concentrations that are exceedances of the regulatory limit are values greater than 5 MCL for Benzene and 25 µg/L RBSL for Naphthalene.
2. Bold and shading indicates above RBSL or MCL.
3. See table 3 for data qualifier definition.
4. Monitoring wells sampled on July 7, 2015.
5. Revision Date: 7/19/2016

Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Feet US
Service Layer Credits: Google Maps Imagery 2016

1 inch = 60 feet

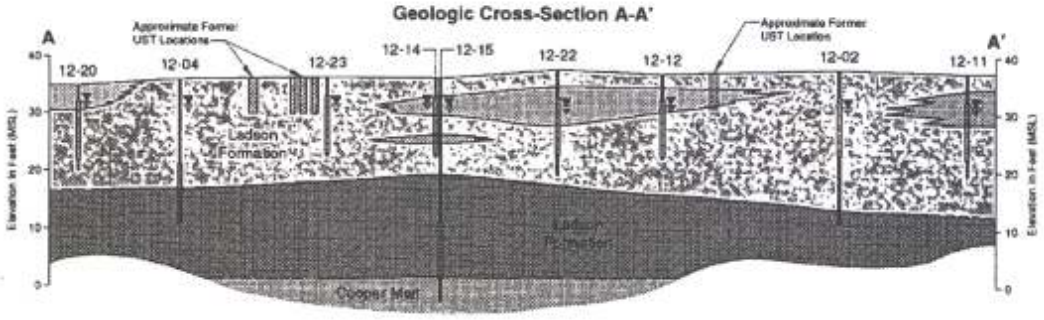
Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC

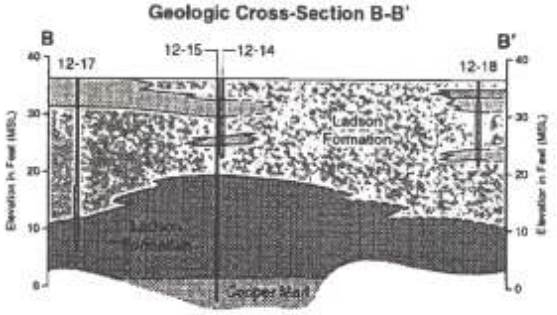
FIGURE 5

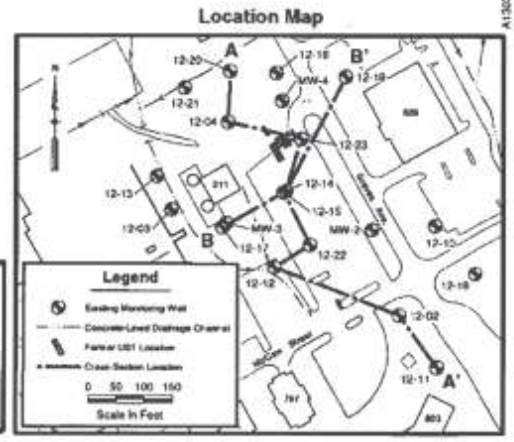
AOC 1 (ST013)
Base Gasoline Station Leak
VOC Concentrations in Groundwater
July 2015

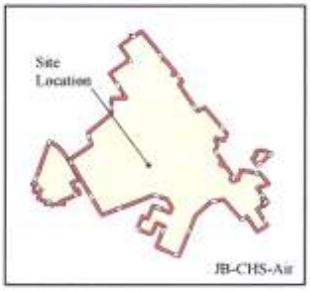
FPM Remediation, Inc.

2016









Performance Based Remediation
Carolina Group
Joint Base Charleston - Air
North Charleston, SC
AFCEC

FIGURE 6

AOC I (ST013)
Base Gasoline Station Leak
Geologic Cross-Sections Dec.1997

FPM Remediations, Inc.

2016

NOTES:
1. Revision Date: 7/19/2016

Coordinate System:
NAD 1983 StatePlane South Carolina FIPS 3900 Feet
Projection: Lambert Conformal Conic
Datum: North American 1983
Units: Foot US
Service Layer Credits: Draft Final Contaminant Assessment Report for AOC I Former Service Station Tank Leak Vol I of II (December 1997)

1 inch = 125 feet
0 15 30
Meters
0 62.5 125
Feet

N
W
E
S

A1320-3 11/08/07 - AUS

APPENDIX D
North Charleston Sewer District Pretreatment Program Limits

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APPENDIX I

12/7/07

FIGURE 2

NORTH CHARLESTON SEWER DISTRICT

PRETREATMENT PROGRAM PERMIT LIMITS

Parameter	Headworks Influent Limit (ug/l)	Industrial Discharge Mnth Avg / Dly Max Limit (mg/l)
Ethylene, 1,2-trans-Dichloro	5.0	5.0 / 7.5
Ethylene, Tetrachloro	5.0	5.0 / 7.5
Ethylene, Trichloro	5.0	5.0 / 7.5
Formaldehyde	120000	20 / 30
Isophorone	77947	20 / 30
Lead	100	1.0 / 1.5
Lindane (γ BHC)	2.906	0.01 / 0.015
Mercury	10.92	0.005 / 0.0075
Methyl Chloride	1000	5.0 / 7.5
Methylene Chloride	1000	5.0 / 7.5
Nickel	250	2.5 / 3.75
Phenol (Total)	4000	10 / 15
Phenol, 2,4,6-Trichloro	974	5.0 / 7.5
Phenol, Dimethyl	11992	15 / 22.5
Phenol, Pentachloro	20000	20 / 30
Phthalate, bis(2-Ethylhexyl)	590	5.0 / 7.5
Phthalate, Di-n-octyl	590	5.0 / 7.5
Propane, 1,2-Dichloro	1000	5.0 / 7.5
Propylene, 1,3-Dichloro	1000	5.0 / 7.5
Selenium	100	1.0 / 1.5
Silver	250	2.5 / 3.75
Thallium	100	1.0 / 1.5
Toluene	35000	20 / 30
Vinyl Chloride	1000	5.0 / 7.5
Zinc	80	0.80 / 1.20
TSS	1200000	1200 / 1800
BOD_5	2240000	2240 / 3360

pH limits 6.5 - 11.5 S.U.

APPENDIX I

12/7/07

FIGURE 2

NORTH CHARLESTON SEWER DISTRICT

PRETREATMENT PROGRAM PERMIT LIMITS

Parameter	Headworks Influent Limit (ug/l)	Industrial Discharge Mnth Avg / Dly Max Limit(mg/l)
	NESO use	
Acrylonitrile	100	1.0 / 1.5
Aldrin	0.0042	0.001 / 0.0015
Antimony	300	3.0 / 4.5
Arsenic	7	0.05 / 0.075
Barium	85657	20 / 30
Benzene	7500	10 / 15
Benzene, 1,2,4-Trichloro	5000	10 / 15
Benzene, 1,2-Dichloro	5000	10 / 15
Benzene, 1,3-Dichloro	5000	10 / 15
Benzene, 1,4-Dichloro	5000	10 / 15
Benzene, Chloro	5000	10 / 15
Benzene, Ethyl	1000	15 / 22.5
Benzene, Hexachloro	0.116	0.001 / 0.0015
Benzene, Nitro	8990	15 / 22.5
Beryllium	58.47	0.6 / 0.9
BHC (alpha)	0.1955	0.002 / 0.00375
BHC (beta)	1.379	0.014 / 0.021
Butadiene, Hexachloro	1000	5.0 / 7.5
Cadmium	1000	5.0 / 7.5
Carbon Tetrachloride	789	5.0 / 7.5
Chlordane	0.066	0.0007 / 0.00105
Chloroform	10000	15 / 22.5
Chromium (total)	250	2.5 / 3.75
Chromium (+6)	250	2.5 / 3.75
Copper	50	0.25 / 3.75
Cyanide	66.62	0.5 / 0.75
DDT	0.075	0.0001 / 0.00015
4,6-Dinitro-2-Methylphenol	32769	15 / 22.5
Endrin	0.069	0.0001 / 0.00015
Ethane, 1,1,1-Trichloro	1000	5.0 / 7.5
Ethane, 1,1,2-Trichloro	1000	5.0 / 7.5
Ethane, 1,1-Dichloro	1000	5.0 / 7.5
Ethane, 1,2-Dichloro	1000	5.0 / 7.5
Ethane, 1,2-trans-Dichloro	28.18	0.25 / 0.375
Ethane, Hexachloro	267	2.5 / 3.75
bis(2-Chloroethyl) Ether	41.97	0.40 / 0.60
Ethylene, 1,1-Dichloro	959	5.0 / 7.5

APPENDIX E
Revised ACQAP Worksheets

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Section B: Measurement/Data Acquisition

B1: Sampling Process/Experimental Design

Item	Start Date	End Date	Comments
Performance Monitoring Groundwater Sampling	After completion of Corrective Action	April 2017 (estimated)	30 days and 90 days after corrective action completion performance monitoring will be performed to evaluate the corrective action effectiveness.
LTM Groundwater Sampling	After 2 rounds of performance monitoring show compliance with RBSLs	April 2018 (estimated)	After performance monitoring shows that the corrective action was effective, quarterly LTM sampling will evaluate the corrective action's long term effectiveness.

Table 5A Sampling Activities

B2: Sampling Methods

Figure 3A depicts the monitoring well locations for the groundwater samples and the approximate excavation boundaries. Please note: The sampling protocols as given in the UST Master QAPP (**Appendix A**) will be followed.

Estimate the number of samples of each matrix that are expected to be collected:

Soil	30
Ground Water from monitoring wells, 2 PM rounds and 4 quarters	30
From Drinking/Irrigation water wells	0
From surface water features	0
Total number of Water samples	30

Note – In addition to the samples listed above, Quality Control samples will consist of trip blanks (1 per cooler containing samples to be analyzed for VOCs), field (equipment) blanks (one per day of field sampling), duplicate samples (one per matrix sampled at a frequency of 10%) and matrix spike/matrix spike duplicate sample (one per matrix sampled at a frequency of 5%). Quality Control sampling requirements are provided in Section B5.

For the sample matrices indicated above, please describe how samples will be collected and the equipment needed.

Prior to collecting groundwater samples, depth to groundwater will be measured to the nearest 0.01 foot using a Solinst oil/water interface meter or equivalent at each well location. Low-flow purging and sampling of the monitoring wells will be performed using a peristaltic pump with Teflon®-lined polyethylene tubing. New Teflon®-lined polyethylene tubing will be used at each well to eliminate the potential for cross-contamination. If a monitoring well is purged dry, the sample will be collected when the well has recharged to a sufficient volume.

Will Sampling Equipment have to be cleaned and decontaminated or is everything disposable?

Disposable Teflon®-lined polyethylene tubing will be used for groundwater sampling, and new tubing will be used at each well to eliminate the potential for cross-contamination. Sampling equipment will not require decontamination.

If sampling equipment must be cleaned please give a detailed description of how this is done and the disposal of by- products from the cleaning and decontamination.

- Not applicable

Identify any equipment and support facilities needed. This may include such things as Federal Express to ship the samples, and electricity to run sampling equipment.

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